INTER AVIA

Review of World Aviation

In this Issue:

Reflections on a Trip to the U.S.A.

L. Clerc : The First Assembly of ICAO

N. J. Hoff : Monocoque Construction — Alexander Klemin : Aileron Combinations

Lockheed P-80 "Shooting Star" — Boeing B-50 — "Speedpak"

Economic Aspects of Aviation — Brussels Aircraft Exhibition

Howard Hughes, "The Enigma from Houston"

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Review of World Aviation

OFFICIAL ORGAN OF THE FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE (F. A. I.)

Volume II — July, 1947 — No. 7

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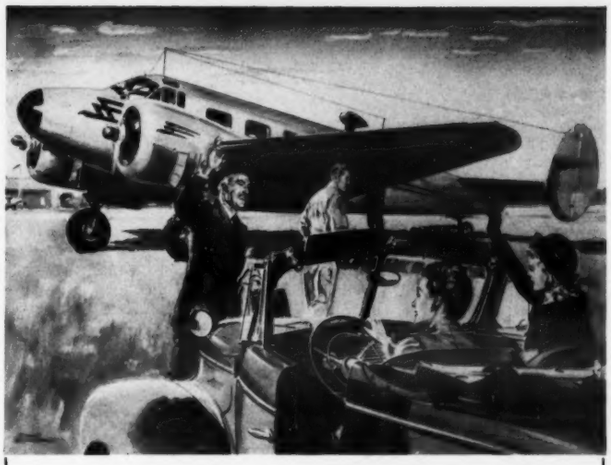

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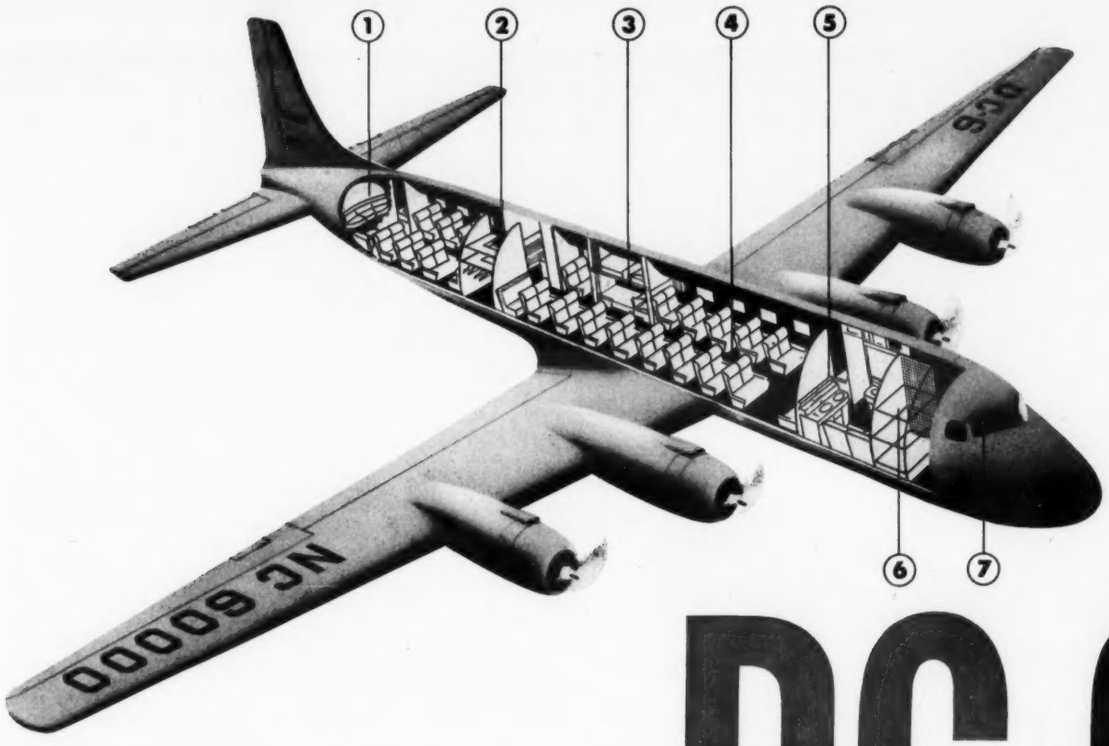

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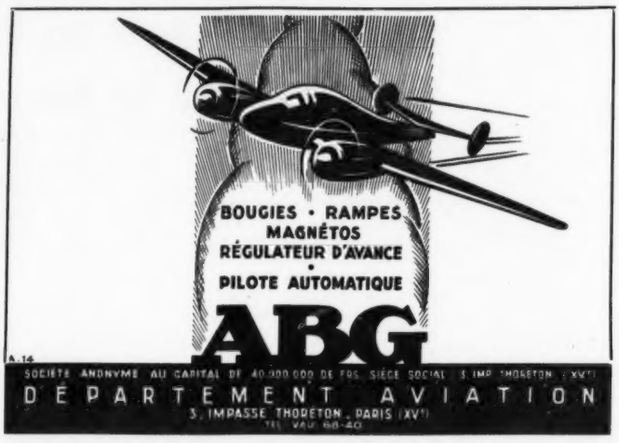

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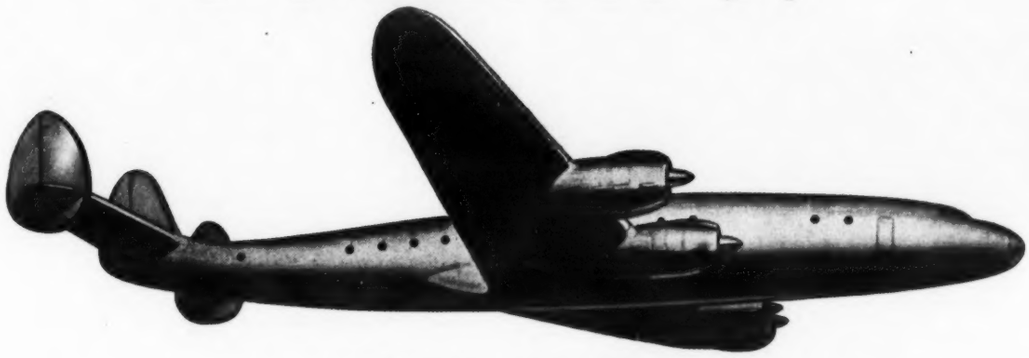

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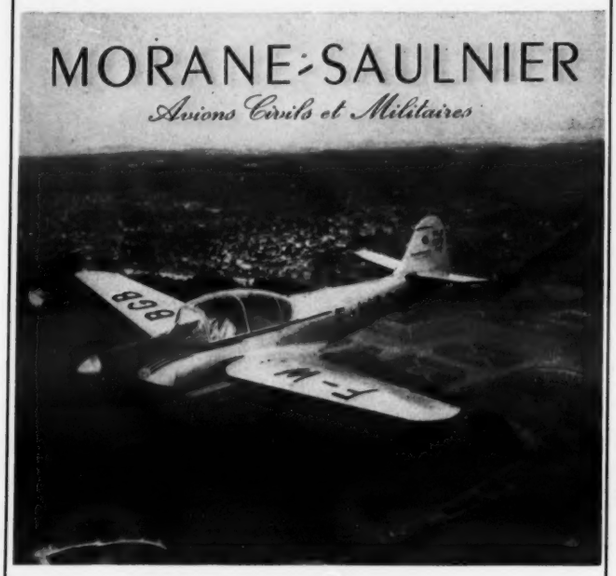

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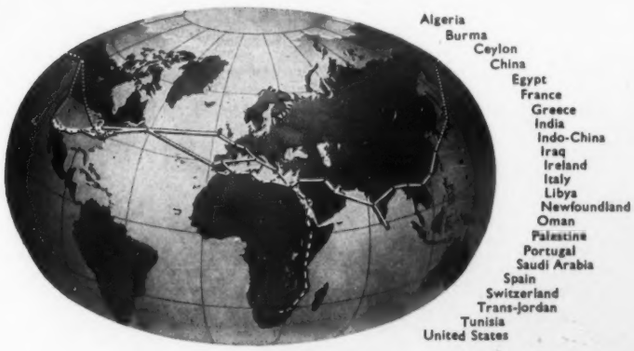

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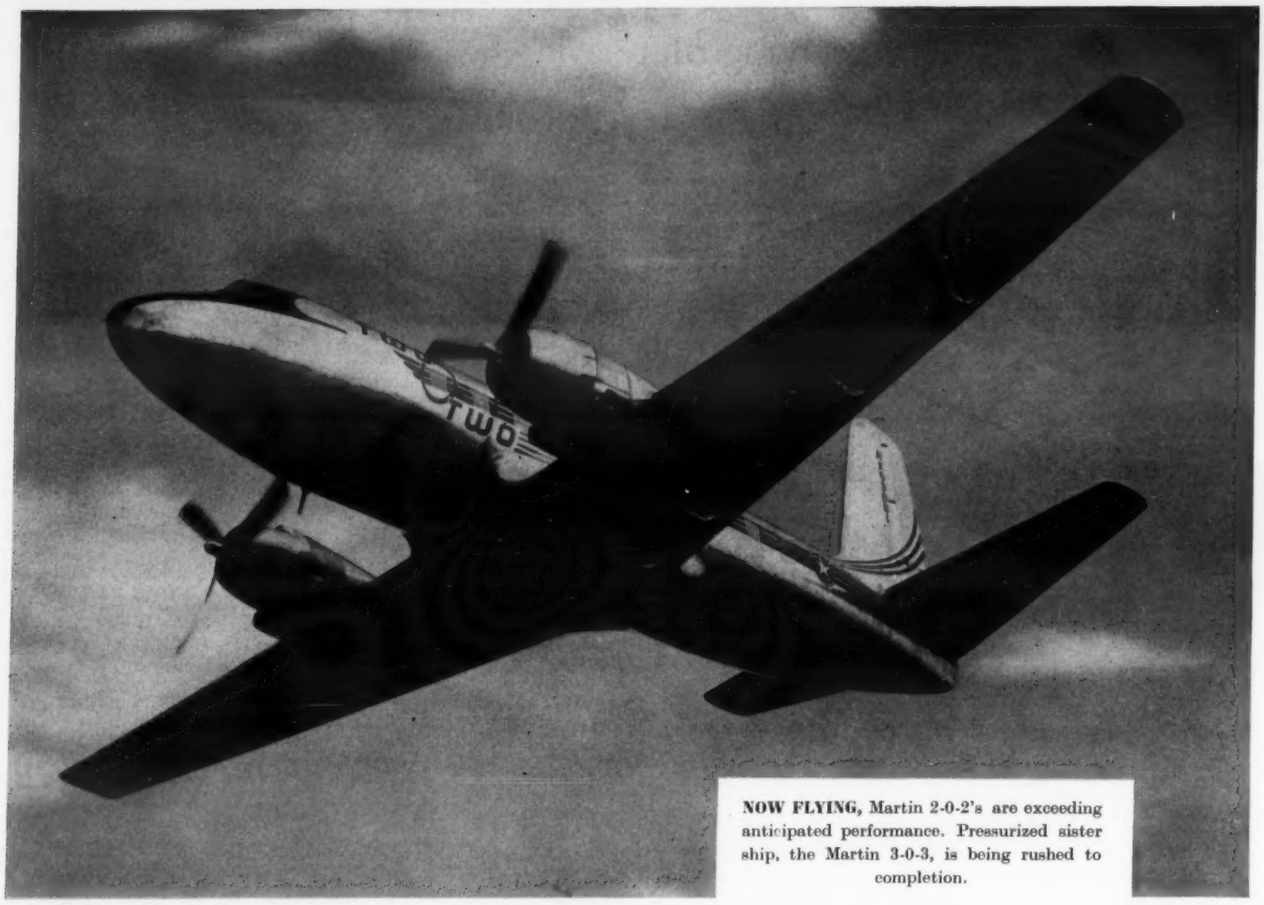

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Marginal Notes

HOW I SAW IT

Reflections on a Trip to the U. S. A.

International politics form the cornerstone of international aviation. Since 1939 their influence throughout the American field has been decisive, they still leave their imprint on U. S. aeronautics, and the path which the world's strongest aviation activity will follow during the next months and years will depend on the political trend.

The case in itself is not at all complicated—in fact it is quite simple.

We can no longer speak of the so-called European equilibrium, the British foreign policy aim of the last decades. Great Britain no longer holds the scales ; she can no longer distribute the weights and watch for the results. Today it is the equilibrium of the world which is in the balance. The East and the West distribute the weights. They endeavour to place small auxiliary weights in their separate sides of the scales, with convincing speeches, promises and gifts, and occasionally with camouflaged threats.

We speak of the United Nations Organisation which, from its base at Lake Success in America, symbolises justice and, blindfold, is charged with balancing the heavy scales containing the might factors of the world. Both the West and the East speak of democracy, but no accord reigns as to the precise significance of this term. We speak of human progress and fail to see that it is primarily technical for the moment, and that social progress lags behind. Finally, we refer glibly to the Air Age and forget that it does not concern a new age, but truly a world revolution.

To classify the developments during the last twenty years in the fields of radio and aviation as simply technical progress, would be just as absurd as to call the great religious reformers of centuries ago, insignificant wandering preachers. Aviation signifies revolution !

Had there been no such thing as aviation, the former German Lufthansa would not have been able to supply Hitler and his cohorts with planes for their election speeches in 1932, with which they raced through the land, instilling madness into the population and thus coming to power. Without aviation, perhaps Messrs. Chamberlain, Daladier and Mussolini would have remained at home, and

Fruitless conference of the UNO Security Council (beginning of 1946) : (left) Russian Ambassador, Andrei Gromyko ; (centre) British Foreign Minister, Ernest Bevin ; (right) former U. S. Secretary of State, Edward Stettinius.

the unfortunate meetings in Munich and Godesberg would not have taken place. Without aviation, Hitler could not have taken Austria and Czechoslovakia and Poland. If it had not been for the German aeroplanes, the French would have been able to stem the advancing German army, which was still a very young instrument in 1940. Without aeroplanes, Hitler would not have given himself to the dream of invading England. Without the so-called Air Age, the last pages of history would not feature the North African campaigns, Pearl Harbour, the atomic bomb ; and the towns of England, Holland, Germany, Japan and many other countries would not lie in ruins today. If that does not signify revolution ! . . .

And now we are trying — to cite Hitler once again — to end this revolution legally and bloodlessly. It is evident where the roots, not of the evil, but of the evolution, lie. Men who, a hundred years ago, hardly knew anything about each other and who, up to twenty years ago, could only establish contact with one another after weeks of travelling, have now been brought nearer together by the Air Age, and have become next-door neighbours. If these neighbours do not soon find a modus vivendi, then, on the basis of our technical progress, this revolution will end in reciprocal extermination.

These are the reflections of a traveller who recently visited the U. S. airline and aircraft

Projected UNO Headquarters near New York.

firms on the East and the West Coast, and spoke with many of the men concerned.

* * *

After numerous fruitless international conferences since the end of the War, the Foreign Ministers of Russia, Great Britain and France are at present meeting again in Paris. What they are really dealing with and talking of is difficult for the wider section of the public to comprehend. But the Russian and the French peasants and the British and American workers read the newspapers and listen to the radio. All these people have but one fundamental desire: to live, to till their pastures and to go about their daily work peacefully. These wishes add up to democracy; and in a democratic-capitalistic country like America, one also calls it "business as usual."

In no other branch of American economic life is business at present so "unusual" as in the aircraft industry. Amidst the confusion of international politics since 1939, Washington has been making the leading men of the U. S. aircraft industry feel like recruits on a parade ground, such has been the issuance of orders and counter-orders.

During 1944, the American aviation industry became the greatest single branch of industry in the whole world. During the demobilisation and disarmament of 1946 this industrial monster had its talons clipped and was told something like this: "You are no longer to behave as a beast of prey and to practice carnivorous habits. Henceforth you are on a vegetable diet and your job is to look after civil aviation." The American Government and tax-paying public proceeded to tame this beast of prey in all earnest. It was not for them to trouble about whether the beast liked it. In the land of democracy where one goes to church on Sundays, places rich offerings in the collection box and is pleased to relieve one's conscience in every possible way, and is very unwilling to destroy anything if it can possibly be avoided, an endeavour is being made to convert the beast of prey into a domestic animal. The construction of large and medium commercial aircraft is being subsidised through the medium of development contracts. The aircraft industry is being urged to build private and touring aeroplanes in order that the Air Age may be changed from a general evil to a general benefit. Of course, a few modern jet fighters and bombers are being built too, and the research on nuclear physics, remote-controlled weapons and suchlike is being continued. But — let's just drop all that talk about Dollar Imperialism and Iron Curtain — the reason is harmless in itself, prophylactic, in case events should ultimately take a turn for the worse. The West is hoping for a friendly echo from the East. Up to the present this echo has not made itself heard.

With all this, the Government in Washington and the American aircraft industry are approaching the ominous crossroads which can lead the so-called Air Age either to Heaven or to Hell. Within a year, the case will either be that the fourteen leading aircraft firms of America will be grouped together to six or eight re-organised concerns; or before long the miles of spacious workshops, today abandoned and silent, will again be the centre of an industrious but, for many, a woeful activity. The latter alternative would perhaps not be distasteful to the aircraft industry executives.

I take my hat off to the executives, engineers and workers. They are building commercial aeroplanes with the same loving care, though with less profit, as they used to produce bombers. I am firmly convinced that it does not signify the last word if a firm of the calibre of North American Aviation recently cancelled, for purely economic reasons, further production of their "Navion" tourer. I maintain that it will be possible to build and sell such aircraft by the thousands once technical and social progress have been brought to the same level, and the buying class has been cultivated throughout all countries and continents. Or, do you not believe that before long the aeroplane will become the everyday vehicle for crossing African and Australian deserts, South American pampas and Russian steppes? Do you really believe that the motor car represents the last word for the peasant or the man-in-the-street? During the process of social progression, all that is necessary is to put this same man-in-the-street in a position to buy his own aeroplane; this is already almost accomplished as regards the motor car. If this were done, there would be a chance that, besides concentrating on atomic bombs and space weapons technical progress would also devote itself more towards promoting safety in the air.

This, too, signifies revolution; and this would be its legal and bloodless course. It is up to us to keep it on the prescribed path.

* * *

To say that America is the land of unlimited possibilities no longer applies. It is a vigorous, youthful land of optimism, which has now reached an epoch where adventures in the Klondyke goldfields and Texas oil regions

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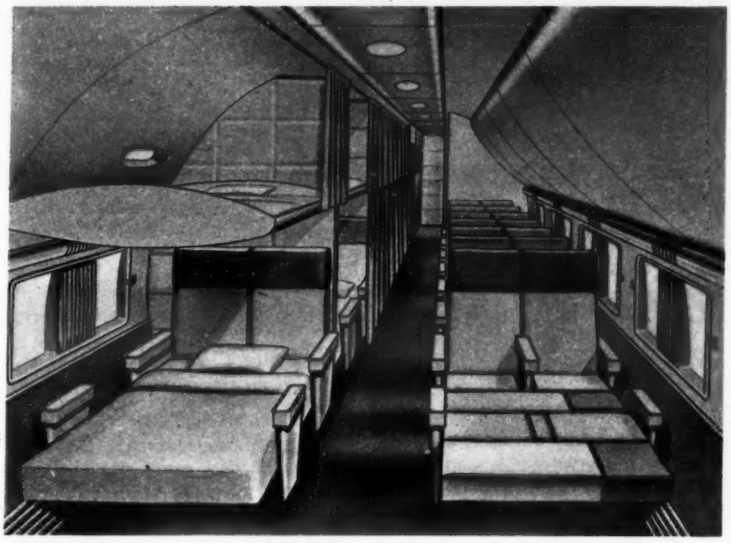


Airliner berth configuration projected by Boeing.

Folding berths on airliners (Boeing project).

are no longer the fashion. It is also a land where distances are greater than almost anywhere else. Nothing fosters the progress of American aviation more than those distances, which had to be bridged in order to promote progress, and which are now flown every day. Are you curious to know just how American civil aviation is faring ? Just as in the case of the U. S. aircraft industry, the airline business is still in a state of transition. However, the relations between the two branches are so close that the woes and joys of the one have a direct influence on the other. Neither one nor the other suffers competition from outside ; they are subjected only to competition among each other.

Apart from the traffic volume, the state of affairs existing at the big American airports is fundamentally the same as that at European air terminals. There is not an inch less of red tape : customs, passport and ticket procedures are far from being ideal. At the Marine Air Terminal at La Guardia Field, the present New York airport for overseas traffic, waiting passengers find it difficult to secure a place to sit down. In the relatively small hall there are hundreds of people awaiting or accompanying arriving and departing passengers. Don't allow yourself to be swayed by the publicity talk of one aircraft taking off every minute. Moreover, don't allow yourself to think that delays and hours of waiting are not an everyday occurrence. And don't expect to find a comfortable restaurant at the airport, a reading room or a bar at which to quench your thirst when the hot, humid climate of the Atlantic coast becomes unbearable. Depending upon the foresight of the airline company by which you are travelling, you are usually left to your own resources and, more often than not, to bore yourself to the verge of tears.

However, there is still much for the European to learn with regard to many small, almost matter-of-fact things. For instance, those who have taken out an airline trip insurance policy in Europe and in America will have noticed how quickly a slot-machine or ticket official in the latter country delivers you a filled-in form for signing, which covers your risks just as advantageously as a European policy does, but costs you a considerable amount less. If European aviation insurance companies refuse to take a lesson from the Americans in this respect, my advice to passengers is that they insure themselves quicker, cheaper and for the same coverage and conditions with the American Underwriters in dollars.

One of the points of cardinal importance is that of conditions on board the airliners. In the case of big airline companies, especially on long routes, the attitude of the flight personnel towards the passengers is exemplary. The air hostesses do more than just look pretty ; throughout every minute of the trip they are devoted to the passengers' comfort. By being extremely polite, but in no way obsequious, the male crew know how to make the passengers feel safe. Before taking off for a long journey, either the captain or the hostess speaks a few words to the passengers, tells them roughly how the weather is, at about what time the next terminal will be reached, or, should there be a risk of bad weather en route, which alternative airfield will be flown to. In a miniature way the aircraft captain borrows an idea from his sea-faring colleague, even if he is not quite able to extend an invitation to dine at the captain's table. Purposely avoiding all official tone, he creates an agreeable family atmosphere ; in short, service to customers and every possible comfort.

* * *

With this we have reached a subject on which the public has so far been misled, whereby the airline operators have consciously and unconsciously contributed towards an illusion and seem to be creating confusion among the public, the aircraft constructors and even in their own circles.

What exactly does comfort on board an aircraft mean ? Where does it begin and where are its limits ?

At the request of certain airline companies, airliners are now being built with sleeping accommodation, whereby the seats can be converted into berths which come to lie alongside the cabin walls and the upper berths fold down from the wall above the windows. All this seems to promise a comfortable trip for passengers, and it all sounds very charming. Only it remains to be answered whether sleeping accommodation on aircraft is really necessary.

Let us just make a comparison between the rights paid for by the ocean-liner passenger and the airline passenger. In return for a goodly sum the sea passenger demands maximum comfort combined with safety. On board ship he finds a few hundred people ready to serve him, a wide and comfortable bed, bathrooms, a ballroom, a promenade deck and many other good things, provided they are not forbidden to him by sea-sickness. On the other hand, comfort signifies weight ; and weight signifies a loss in speed. This is one disadvantage he has to take into consideration if he wants to go by ship.

What are the rights of the airline passenger ? Above all, he demands speed and safety. The first duty of the aircraft constructors and the airline companies is to apply every means to foster these decisive factors. But if one exaggerates the comfort factor on board aircraft, it is evident that additional weight will be involved, and thus a reduction in speed. Berths on board airliners necessarily entail a reduction in the number of passengers and, logically enough, an increase in fare. The

conception of sleeping accommodation on board thus adds up to losses for the airline operator. They are therefore confronted with the question of whether berths should be provided at all.

After studying the matter carefully one is inclined to say no. The fastest and most direct way of flying is the ideal one. It will be noticed that, precisely for this reason, minor airline companies are switching over to international services, because they wish to spare their national passengers, or those travellers who touch their territory, the inconvenience of waiting around air terminals. For air trips not lasting more than twelve to fourteen hours, the present comfortable seating accommodation should be sufficient, insofar as the service on board is kept to its present high level. The weak point in airline comfort, namely, chaining passengers to their seats, will just have to continue, and promenade decks for this costliest of all transportation methods are not to be hoped for.

All the same, certain people have given themselves over to fantastic ideas of promenade decks and suchlike for the airliners of tomorrow. The supporters of such ideas maintain that the aircraft of today are merely transitional types and believe in the future of giant flying-boats which will go from port to port like ocean-liners. One can very well argue that all flying equipment, present and future, automatically denotes transition : each type is constantly being superseded by a better one. On the other hand, the conception of operating flying-boats to provide passengers with the same comfort as they can get on ocean-liners is contrary to the fundamental aim of air travel.

Meanwhile, there is strong evidence of a developmental tendency along these lines in certain European countries. However, it is hard to believe that these principles will reach their goal within reasonable time ; and it seems certain that American aviation will continue stubbornly to adhere to the fundamental purpose of air travel. The future American flying equipment will be designed along lines which endeavour to fulfil the desire for increased speed, for instance, a North Atlantic crossing in five to six hours, and they will be powered with gas turbine engines. And such desires do not point to giant flying-boats or aircraft with sleeping accommodation. The middle name of air travel must be speed.

British high-speed jet project : Handley Page "Hermes V," to carry 63 passengers at 350 m.p.h. cruising.

* * *

Thus the aircraft and airline industries of the U. S. A. are seeking new vistas. " If all goes well," the industry will have been converted, proportioned and consolidated on a peace-time basis before a year is over. The factories will have been reduced in both number and size. At present there are perhaps a little too many airlines companies too. There is every possibility that the sixteen domestic carriers today existent in the U. S. A. will be consolidated to about ten during the next twelve months, and that the three big overseas airlines will have been grouped to two big concerns. For the time being these are, of course, hypotheses ; and though they depend on the development of business in general they also depend strongly on international politics.

In the shadow of transition the American aircraft and airlines industries—with a few exceptions — are losing money. The aircraft industry is losing because it cannot yet fully discern whether the armed forces are soon to become its main customers again, or whether there will remain as minor customers and civil aviation will become its best client. The airline operator is in the red because he has to go on seeking new aircraft, new customers and an altogether new traffic policy. It is probable that the casual observer has hardly realised how strong the fundamental difference is between the airline business and other transport undertakings. Railroad, highway and shipping transportation depend primarily on freight and cargo carriage for their main income. Heretofore, civil aviation has made the majority of its profits from the most exacting, " highest-density " and most sensitive " item " known to any branch of transportation, namely, human cargo.

Coming back from America, it must have occurred to many Europeans interested in aviation that, in most parts of Europe, one is just content to fly, whereas the Americans are already seriously considering how to fly.

* * *

The Pentagon Building in Washington, brain of the U. S. Army.

With a few rough strokes of the brush the basic outlines and developmental tendencies of American aviation have been painted as the narrator saw them. With intention, no details have been related with respect to the American air arm, which is still the strongest in the world, even if the aircraft of yesterday are slumbering on airfields and in hangars, and the aircraft of tomorrow are only being delivered in small series.

But whatever the rôle ascribed to the aeroplane, whether peaceful or belligerent, we should once and for all realise that is the chief instrument of a current revolution. This revolution is in no way near to its end ; it is in full bloom. The writer has endeavoured to sketch its legal and bloodless course as seen through the eyes of the Americans. An attempt to lead it through any other channels would be foolhardy.

EEH.

Shooting Star

Lockheed P-80B : note the two dive brakes beneath the fuselage ; external differences from the P-80A noticeable from the re-modelled air ducts and jet outlet.

Has the world speed record of 616 m.p.h. (991 km/h) held by Great Britain since September 7th, 1946, been broken ? It is reported from the U. S. A. that Colonel Albert Boyd, Chief of the Flight Test Division at Wright Field, Ohio, made several flights on June 19th with a special version of the *Lockheed P-80 "Shooting Star"* jet fighter at the Muroc Dry Lake experimental base in California, and exceeded this speed.

As is known, every claim to a record in the air must be examined and recognised by the F. A. I. (Fédération Internationale Aéronautique). Boyd's flights were carried out in accordance with F. A. I. regulations, but there has so far been no announcement that the new world speed record has been homologated.

It is evident from the fact that the usual fanfare of publicity was not heard, that the Americans were surprised by the success of the flights on June 19th. It so happens that, since the first unsuccessful attempts to beat the British record, a curious silence has prevailed in connection with the P-80 " Shooting Star." This plane has been manufactured in large series and is known under the designations P-80A and P-80B as one of the standard fighters of the USAAF. Both versions are powered with General Electric I-40 gas turbines giving a static thrust of 4,000 lbs.

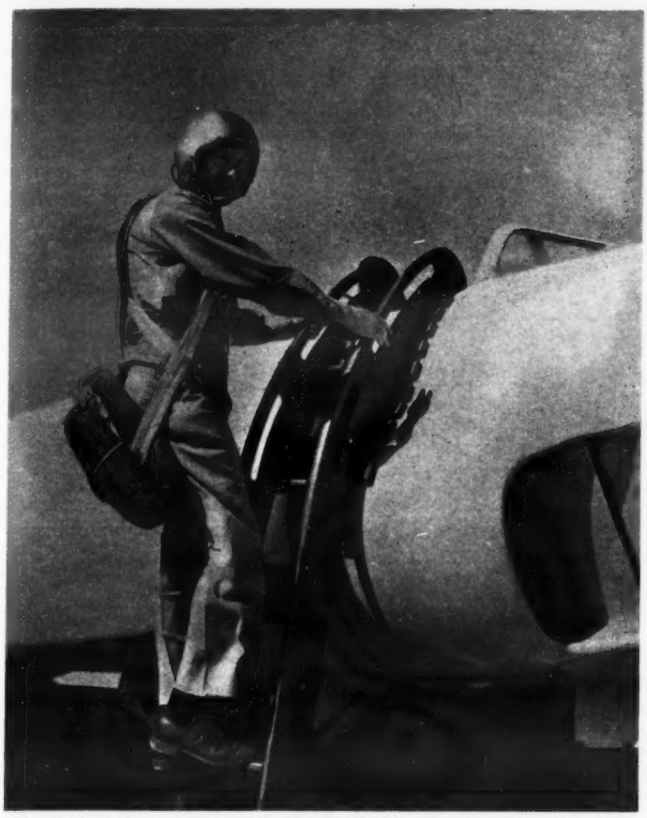
Meanwhile, the Lockheed Aircraft Corp. did not remain idle, and in all secrecy developed a new prototype, the *P-80R,* which resembles the standard version externally but is powered with the latest U. S. gas turbine engine, the *Allison Model 400.*

Colonel Boyd made altogether eight runs over the prescribed 3-km course, whereby all were followed with a recording camera. The results from each two flights in one direction were 617 m.p.h. (992.91 km/h), 615.7 m.p.h. (989.05 km/h), 632.6 m.p.h. (1,017.69 km/h) and 630.5 m.p.h. (1,014.47 km/h), thus an *average speed of 623.8 m.p.h. (1,003.6 km/h).* For peak outputs during short periods, the Allison engine can use water injection. During his flights Colonel Boyd was constantly in radio contact with the ground and gave a signal each time he applied water injection.

At the beginning of 1946 when the preparations at Lockheed's were being made for an attack on the speed record with a P-80, the test pilots very soon encountered dangerous compressibility phenomena which, extending from the ailerons, entailed violent disturbances of the airflow along the wing. With the wing form as it stood, these disturbances could not be eliminated, so that AAF pilots had to keep the top speed of the P-80A below 600 m.p.h. By fitting a new leading edge of greater depth and simultaneously increasing the wing area, the thickness/chord ratio of the wing could finally be reduced. After the cockpit canopy had been subjected to certain refinements, thorough trials were begun with the new version, designated *P-80R* (R for Racer), which was still fitted, however, with the standard General Electric I-40 engine.

P-80B "Shooting Star": the only protruding antenna is the short rod visible forward of the dive brakes, beneath the fuselage.

Lockheed P-80A being test-flown over the desert areas of New Mexico.



Colonel Albert Boyd climbs into the P-80R "Shooting Star," special version of the P-80 powered with an Allison Model 400 jet engine, with which he beat the British-held speed record on June 19th, 1947.

Six fixed 12.7-mm machine guns are built into the nose of the Lockheed P-80B; one of the ammunition belt containers is visible in front.

The outside world heard very little about these trials, for already then the sight of a flying jet fighter was no longer anything unusual. Apart from this, the modifications were scarcely perceptible to the uninitiated. All the same, it did happen once that the secret was close to being let out of the bag. During the summer of 1946, a test pilot miscalculated his landing; the P-80R shot over the edge of the field and was severely damaged. However, not a single one of the eager reporters was able to conclude anything special from the new wing configuration of what they thought was the ordinary P-80. After the precious prototype had been repaired and water injection had been experimentally fitted to the G. E. turbine, it was transferred to the Muroc test base, where all high-speed aircraft are put through their paces. The idea was to try it out alongside the Republic P-84 "Thunderjet"* preparatory to an attempt on the speed record.

At the beginning of last September the tests with the "Thunderjet" succeded in coming very close to the British record (a breakdown of the recording camera made it impossible to measure the time exactly), but the "Shooting Star" had bad luck continuously. Engine failures and oscillation in the air ducts prevented it from taking part in this show, which was simultaneously to have been a match between the two planes.

* cf. "INTERAVIA, Review of World Aviation," No. 6, June, 1947.

Subsequent spells of bad weather caused further attempts on the speed record to be postponed until spring, 1947. Then there was another delay because Lockheed wished to await delivery of the new *Allison Model 400* gas turbine. No precise data has yet been released on this new engine, but it is said to be capable of delivering a static thrust of 4,600 lbs. "dry," which can be stepped up 7,000 lbs. during short periods with water injection. Fitted to the Lockheed P-80R "Shooting Star" just two weeks before the record flights of June 19th, this new jet unit permitted the U. S. A. to beat the British achievement and to make a new step towards the sonic barrier.

All "Shooting Star" jet fighters of the U. S. Army Air Forces are equipped with ejection seats: (left) seat with built-in parachute, (right) pressure cylinder and ramp.

For the Lockheed Corp., which has meanwhile subjected the air ducts to various improvements and slightly lengthened the jet outlet, these flights also served to prove that there is no need for P-80 pilots to fear undesirable compressibility influences at speeds up to 623 m.p.h. Moreover, the firm may now entertain the hope that the U. S. Army, which, impressed by the performance of the Republic "Thunderjet," has ordered a large number of the latter, may now consider the possibility of the P-80R "Shooting Star" as a front-line fighter. Should this be the case, the Army version will be designated *P-80C*.

It has already been confirmed that the P-80B series, some of which have already been delivered to the AAF, will be fitted with the Allison Model 400 instead of the General Electric I-40 gas turbine.

During the course of this summer the diving characteristics of the P-80R will be thoroughly investigated at the Muroc Base. Flights at high Mach Numbers have so far been withheld because it was not wished to expose test pilots to undue risks. However, it will now be possible to equip the "Shooting Star" with a remote-control device developed by Bell Aircraft Corp., which will televise the instrument readings to a ground station. This apparatus should enable unmanned flights up to altitudes of 45,000 ft. and distances of 100 miles from the ground station, to be followed with great precision.

Bi.

ICAO

Colonel Louis Clerc, Head of the Swiss Federal Air Office, is known to our readers by his contributions to "Interavia Review" during 1946. He took part in the Montreal discussions and has placed the following report at our disposal. *The Editor.*

THE FIRST ASSEMBLY OF ICAO *May 6th to 27th, 1947, in Montreal*

The First Assembly of the International Civil Aviation Organisation was declared open on May 6th, 1947, at the Hotel Windsor in Montreal by the President of the PICAO Interim Council, Dr. Edward P. Warner. The Canadian Minister of Reconstruction and Supply, Clarence D. Howe, and the Mayor of Montreal, Camillien Houde, greeted the gathering in the name of the Canadian Government and of the City of Montreal. Approximately 380 persons represented 34 member States, ten non-member States and eight international organisations which had sent advisers and observers to the sessions of the Assembly and various committees.

The *first session* was confined to the settlement of a number of formalities, after which addresses were delivered by the chiefs of the separate national delegations.

The *second session* was held during the afternoon of May 7th. After a new series of addresses by the delegation chiefs the President and Vice-Presidents of the Assembly were elected.

The Swiss delegation (left to right): R. Thiébaud, Prof. E. Amstutz (Chief), Colonel Clerc (author of this article).

On May 8th six Commissions (cf. Interavia 1947, No. 4 "ICAO Agenda") commenced the tasks allocated to them.

In the *third session* on May 13th, the Assembly dealt with two important points: *conclusion of an agreement to affiliate ICAO with the United Nations Organisation; Italy's application for admission to ICAO.*

The affiliation with UNO was agreed to unanimously. However, the United Nations had set a condition, without fulfillment of which it refused to sanction this affiliation: *Spain should not be admitted as a member of ICAO as long as Franco remained in power* (cf. Interavia 1947, No. 6, "Aviation with Obstacles"). Because the Chicago Agreement did not recognise the expulsion of a member State for political reasons, it had to be supplemented by a new article; this was accepted by 27 votes against three (two abstaining). Immediately after the vote, the Spanish delegate left the conference room and did not participate in the subsequent meetings. Meanwhile, it is to be regretted that an international organisation aiming to promote aviation technics, air safety and the economic development of civil air transport, should be forced by politics to oust a country which was thoroughly prepared to help towards realisation of the aims of Chicago. Politics and science belong to separate camps.

Italy's application for admission was supported by the U. S. A. and Ireland. France and Greece, who, according to Article 93 of the Chicago Convention, could have applied their veto, chose to vote in favour of Italy's admission.

Hence, at the *fourth session,* Italy was admitted unanimously as a member State, though it still remains for UNO to lend its approval.

At the *fifth session* on May 21st, it was decided to distribute the 21 seats on the Council in the following manner:

A. Eight seats to States of major importance as regards airline operations.

B. Seven seats to States of major importance as regards contribution towards air navigation.

C. Six seats to States whose nomination would ensure that all the principal regions of the world be represented on the Council.

At the *sixth session* the following States were elected to the ICAO Council:

Group A. Belgium, Brazil, Canada, France, Great Britain, Holland, Mexico, the U.S.A.

Group B. Argentina, Australia, China, Egypt, India, Ireland, Portugal.

Group C. Chile, Czechoslovakia, Iraq, Peru, Sweden, Turkey.

At its *seventh session* on May 23rd, the Assembly approved the provisional report of the 2nd Commission (Technical Questions), which had recommended that the Council establish contact with the International Air Transport Association (IATA) and the aircraft manufacturers in order to find a way of limiting the constantly increasing requirements as regards length and strength of runways. It was pointed out that *countries cannot be asked repeatedly to make new allocations for lengthening and strengthening their runways.*

In accordance with the recommendations of the 1st and 4th Commissions, a permanent Air Law Commission was established. Given the task of continuing the work of CITEJA (Comité international technique d'experts juridiques aériens), its duties will include the drafting of international air law agreements, advising ICAO in air law matters, and keeping in touch with all international bodies aiming towards the simplification and codification of international air law.

In its *eighth session,* held on May 26th, the Assembly examined the final report of the

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THE AIRPORT, SOUTHAMPTON, ENGLAND

The Hon. C. D. Howe addresses visitors to the opening plenary session.

2nd Commission containing the resolutions relative to means of facilitating the participation of Contracting States in the meetings of the ICAO Divisions, the establishment of regional sub-committees on civil air transport, and a recommendation to the Council for the standardisation of certain units of measurement used in air-to-ground communications.

At the *ninth session* on May 27th, when the final reports of the 4th, 3rd and 1st Commissions were examined, it was decided to ask Contracting States to submit their recommendations for the internationalisation of trunk routes.

In the face of fundamental difference of opinion between the participant governments, *the draft Multilateral Agreement* submitted by the 3rd Commission *could not be accepted.* In order that this agreement may be discussed at a later date, the Assembly decided to call a *conference next October in Rio de Janeiro,* to which all member States are invited. One cannot help admiring the optimism of the Assembly. It so happens that fruitless discussions on a projected Multilateral Agreement have been going on since 1944. Can one really believe that, within a few months' time, nations will change opinions which they have vigorously upheld for about four years ? The organisation was then asked to establish

The Hon. C. S. Drakeford, Chairman of the Australian delegation and Australian Air Minister, delivers his address after his election as President of the ICAO Assembly.

After adoption of Article 39 bis, leading to the expulsion of Franco Spain from ICAO, E. F. Terradas, head of the Spanish delegation, leaves the Hotel Windsor.

Belgium, a country with ambitious aviation plans, obtained a seat on the Council. (Left to right) : Lieut.-Col. Jean Verhaegen, E. Allard, P. A. T. de Smet.

a *definition of "non-scheduled carriers"* in such a way that these can be distinguished clearly from scheduled carriers.

The Council was given authority to act as an arbitral tribunal in cases of differences between countries on questions of civil air transport, insofar as the parties concerned choose to submit such differences to the judgement of the Council.

The *last session* was held in the afternoon of May 27th.

The 1945-1946 accounts were approved. The Assembly adopted a new set of financial regulations and the draft budget for the fiscal year from July 1st, 1947, to June 30th, 1948. The latter foresees a total expenditure of Can. $ 2,600,000.

*

There is no doubt that the Assembly and the Commissions accomplished a great deal during the three weeks of the meeting. It is not to be regarded as a sign of weakness or impotence on the part of ICAO if certain important matters on the agenda could not be brought to a final conclusion : e. g., the Multilateral Agreement, Convention on the Registration of Ownership and Mortages of Aircraft, the Legal Position of the Aircraft Captain, and the Revision of the Warsaw Convention. These problems are excessively delicate and demand close and tedious study on the part of member States ; and the latter have no desire to settle such problems in a superficial manner. On the contrary, the Organisation was quite right in listing these questions on the agenda again, even if it was sure that they could not be settled during the course of this meeting, for its only through discussion that one can come to an understanding. Moreover, we have no doubt that this understanding will finally be achieved.

Louis Clerc.

P. A. T. de Smet explains the projected ICAO building in Montreal to André Perraud and Dr. Edmond Sudre, both from Paris, representing CITEJA (now in liquidation).

CASTLES IN THE AIR *The Multilateral Civil Aviation Agreement*

I. What does "urgent" mean?

On the opening day of its First Assembly in Montreal, the International Civil Aviation Organisation (ICAO) gave out a news release listing the following *four points as particularly urgent : Multilateral Agreement for the granting of air freedoms to all member nations,* joint support of internationally-needed facilities which individual nations cannot provide, affiliation of ICAO with the United Nations Organisation, and air safety on an international basis.

The fact that the Multilateral Agreement is listed as the first of the chief points is not surprising, for it is a subject which was already described as urgent in 1944.

All preparations had been made for an "urgent solution." The Commission on Economic Questions submitted a document (Doc. 4014, A1-EC1) dated March, 1947, which contained, besides a report of the Air Transport Committee, the draft Multilateral Agreement on commercial rights in international civil air transport, a commentary on the Multilateral Agreement and finally a statement of minority views.

There were now two possibilities : the Assembly could either accept the draft, as it stood or with certain editorial modifications, or reject the proposed Multilateral Agreement and revert civil aviation to its present unsatisfactory system of bilateral pacts.

Delegates confer at the ICAO General Assembly. Shown attending are the representatives of China (outside left) and India (third from right), two countries against the Multilateral Agreement. Czechoslovakia (second from left) Norway (third from left) and Sweden (outside right) are in favour of the Agreement. The Irish delegate (fourth from left) submitted a separate Irish draft for a Multilateral Agreement.

Seated are Sir Frederick Bowhill (foreground) and Sir James Cotton, members of the United Kingdom delegation. Sir James Cotton already opposed the Multilateral Agreement whilst it was in the PICAO Air Transport Committee stage.

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However, the Assembly found and chose a third way out which entailed no definite decision but, as so often happens at international conferences, was a formal solution in line with the rules and procedures. A Special Committee has been established and given the task of dealing with the Multilateral Agreement as drafted by the PICAO Air Transport Committee. An extraordinary meeting will be held in Rio de Janeiro next September or October to discuss the progress made by this special committee and—providing PICAO history repeats itself—to establish another "special committee" of which the progress will be reviewed at a later conference . . . etc.

In this manner an otherwise painful theme takes on a pleasing and artistic aspect, just as in the tales of the antiquity a dialogue well-known to everybody is repeated again and again, with new people taking the old rôles, and slight modifications in the text, but where the result is known from the start.

For a long time already, airline companies and airline passengers have been waiting "urgently" for civil aviation to adopt those facilitations which have been an understood thing in shipping operations for many years. However much one insists on making learned declarations on the fundamental differences in national rights between "air space" and "high seas," "seaports" and "airports," "territorial waters" and "sovereignty air space," there is no denying the fact that an American steamer can dock in Cherbourg, Southampton or Lisbon at any time it likes, just as a Dutch ship can unload its cargo in New York, Rio or Buenos Aires at will, without the previous conclusion of a bilateral agreement to regulate every small detail of capacity or frequency. An outbreak of war, a contagious disease on board, or disregardance of the regulations established by the local Port Authority are about the only occurrences which can prevent a ship from docking at a foreign port. In shipping the rule is "freedom of traffic with certain items forbidden," whereas for civil aviation we could say "everything forbidden except for certains item allowed."

It is not to be inferred from the fact that in these pages we have constantly urged a restriction of national sovereignty that we wish to cast aspersion on the air policing prerogatives of national governments. Our only desire is to emphasise the necessity of granting international civil air transport a minimum amount of freedom of movement ; and this freedom of movement has always been denied to airline operations because it was assumed that it could endanger national sovereignty.

Let us cut out the diplomatic tone and talk plain English : certain officials are afraid, not of bombs which might be dropped unexpectedly, but of the scheduled landing of cargo and passengers. For this reason they have fortified themselves behind the argument that any civil air transport plane can be converted into a murderous bomber in the twinkling of an eye. They say "protect all that is dear to us" and mean "protect all that is lucrative to us."

For this reason the nations could neither accept nor reject the draft Multilateral Agreement, and chose to bury it beneath a mountain of special committees and new conferences.

II. The Draft—A Cherished Desire.

In Fig. 10 of its report, the Air Transport Committee says :

> "The Agreement seeks to confer a regulated freedom of the air under which all States will have equal and reciprocal commercial rights. The majority of the Committee has thought that such freedom should confer the actual right to fly, without provision for supplementary arrangements as to routes . . ."

Effectively, Article 6 of the draft formulates the freedom of the air in a straight-forward manner with which we are entirely in accordance :

> "Subject to the provision of this Agreement, each Contracting State shall have the right that its duly authorised airlines shall be entitled to fly their aircraft across the territory of any other Contracting State without landing and to make, in such territory, stops for non-traffic purposes and for the purpose of putting down and taking on passengers, mail and cargo."

Contrary to previous practice, the remaining twenty-three articles of the draft place no restrictions on this global freedom, but serve solely to regulate the details. They establish a sort of most-favoured nation clause for all Contracting States with regard to third parties (Articles 2, 3, 4 and 5), provide for the appointment of an Arbitral Tribunal to deal with any disagreement arising between Contracting States (Article 17), and cover in a broad and flexible manner the permissible capacity and frequency operations (Articles 8, 10 to 13).

Characteristic is that the opposing States are not against the formulation of the rules on permissible capacity, which are intentionally drawn up on very broad lines, but insist that the enforcement in each separate case be made dependent on bilateral arrangements between governments concerning the establishment and allocation of routes. However,

Delegates from three Scandinavian countries disembark from a Scandinavian Airlines System DC-4 at Dorval Airport, Montreal. The Scandinavian countries are staunch supporters of the Multilateral Agreement proposal.

The head of the U. S. delegation, Garrison Norton, addresses the First Assembly of ICAO.

"The Americans could write revealing memoirs on their experiences with bilateral air agreements." Left to right: Garrison Norton, head of the U. S. delegation; Major-General Lawrence S. Kuter, U. S. representative on the ICAO Council; W. A. M. Burden, Assistant Secretary of Commerce; James M. Landis, Chairman of the U. S. Civil Aeronautics Board.

this suffices to invalidate Article 6 and to torpedo the Multilateral Agreement on commercial rights in international civil air transport.

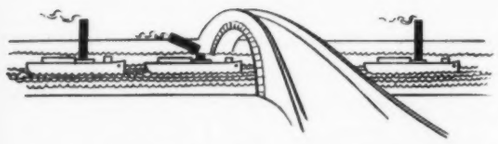
Members of the Air Transport Committee in favour of the proposed agreement are Brazil, Canada, Czechoslovakia, France, Holland and Norway. The Irish delegate, who presented his country's own suggestion for an agreement, abstained from voting. The fact that, besides China and India, Great Britain is against the proposal for altogether unrestricted freedom of civil aviation is not surprising, in view of her unchanged attitude since 1944. New is that America has finally thrown her free trade principles overboard, with the result that the unyielding attitude of the U. S. delegation forced the conference to adjourn on this point. The American delegate John C. Cooper may certainly be regarded as a faithful interpreter of the opinions of his countrymen: as a practician and a theoretician he has left no stone unturned during the past years in his efforts to foster the creation of a generally binding agreement.

In a magazine article circulated in Montreal immediately prior to the meeting, he vigorously attacked the proposed multilateral agreement:

> "The Civil Aeronautics Board (if it adopted the draft) would be barred from denying a permit to any foreign line that sought to fly any place in the United States, and the President's hands would be tied because the Agreement would come into force as a Treaty."

One might have thought that the U. S. A. and her air authorities had had enough experience to realise the urgency of a multilateral agreement. Since the end of the war they have been fighting for landing rights in South America and India. And since the end of the war their efforts in these directions have been uphill. Braniff Airways, Pan American Airways and the C. A. B. could, if they wished, publish revealing memoirs on their adventures with bilateral civil aviation agreements. Meanwhile, however, the stiffened U. S. attitude is not primarily based on the U. S. State Department's aviation politics. It is entirely in line with the attitude which has featured throughout U. S. commercial policy during the last months. Despite several official declarations to the contrary, there is no denying a present tendency towards protective duties and other prohibitive measures.

He.



Boeing Sees It Through

At the end of 1945, when Boeing Aircraft Co., of Seattle, had completed the prototype of their four-engined C-97 long-range aircraft and were ready to present it under the name "Stratocruiser" to the world as the most up-to-date trans-Atlantic airliner of the day, the firm's engineers got a truly unpleasant surprise. When the sliding doors of the hangar were opened ready to unveil the so far secret prototype to the public, they discovered that there was not enough headroom to let the great vertical tail, standing 38 feet 3 inches high, pass through. As a result, the ceremony had to be postponed until a team of workmen with welding equipment had cut away a suitable portion of the structure above the hangar door.

As Boeing's aerodynamists thoroughly favour the single, central fin arrangement for all their large aircraft, the designers had to find a solution to this new problem. It was only too evident that the airlines would be loth to acquire new hangars for their new "Stratocruisers." Moreover, the same problem arose in connection with the U. S. Army's latest four-engined superbomber, the Boeing B-50, a development of the B-29

" Superfortress." In a way, Boeing's designers were faced with the same problem as the designers of naval fighters, who had to conceive the folding-wing configuration to cope with the restricted hangar space on aircraft carriers.

The problem was attacked and duly solved ; and the " Stratocruiser " as well as the series of over 130 B-50 superbombers being built for the USAAF are being fitted with a novel device which permits the *fin and rudder unit to be folded down to a horizontal position.*

When the idea was first made known, the airline operators feared that it would considerably complicate maintenance. Not until they saw with their own eyes that simplicity was the keynote of Boeing's principle, did they lend their approval.

The all-metal vertical assembly is anchored to the fuselage by four main terminal bolts. The first step in folding the tail is to replace these four bolts by two hinge bolts on the right side of the fin. After that a tripod-and-crank device, known as a " fin-folding jack " is bolted on to the left horizontal stabiliser and the nose of the jack's actuator screw fitted to a nut-plate on the surface of the fin. When turned by a handcrank the long-nosed screw pushes against the fin and gently tips the entire vertical unit over on its right side, squarely on top of the right horizontal stabiliser. The torque tube carrying the rudder controls incorporates a torsion link with flexible joints, so that the connection is retained when the rudder is swung over. Similarly, extensions have been inserted in the electrical leads to the tail ; and the anti-icing duct is built with a telescopic section that stretches during the folding operation. Hence, there is nothing to be disconnected but the four main terminals which hold the fin erect. The section of the dorsal fillet incorporated in the fuselage is not folded.

Whereas the highest point of the fin, and of the plane, is normally at 38 ft. 3 in. above the ground, this new principle brings it down to 26 ft. 7 in., so that the aircraft can be stored in any major airline's hangar. Incidentally, it is not necessary to tip the tail entirely ; the fin-folding jack is capable of holding it in any intermediate position, and strongly enough to withstand a stiff wind.

The Boeing B-50 is the USAAF's most modern four-engined (piston) long-range bomber. It bears a marked external resemblance to its predecessor, the B-29, but has much more powerful engines (P & W " Wasp Major " twin-row radials of 3,500 H.P. at take-off). As a result of this extra power, the fin-and-rudder unit, already very high in the B-29, had to be designed 5 ft. taller. Only in this way could the CAA regulation for four-engined planes be fulfilled, namely, not more than 5 deg. yaw for taking off with one engine dead. *Bi.*

Merry-go-round on Wings...

Flying round the world is no longer the privilege of millionaire sportsmen. Thanks to an airline company—an American one, of course—this former feat of heroes has been relegated to a scheduled basis, so that global trips are now within easy reach of the ordinary, common or garden millionaire-in-the-street.

The idea is that one takes off from New York and lands there again after having "looped the loop" round the globe. The first services are being flown once weekly, but if people fall for the stunt, the frequency will be increased accordingly. Thus, there is a strong possibility that a daily service will ultimately ensue, in which case pilots will be having a grand time playing "follow-my-leader" across the skies.

Whilst the organic winged species are taking their nocturnal rest, our winged monsters of metal continue to point their noses skywards. During the daytime, however, they come to rest in some of the world's capitals, so that the passengers may have a chance to "see the sights." When one comes to think of it, it must need some fast running and pretty nifty skimming through Baedeker to see everything worth seeing in London, Istanbul, Calcutta or Tokyo in just one day. In fact, it looks as though the real records will be on the ground rather than in the air.

Just think of the confusion of passengers' memories once they have landed in New York again. I really think that one would have more fun listening to the "globe-flyers" effusions than actually undertaking the trip. I can imagine Mrs. Schinkenbaum-Smythe (Riverside Drive) :

"Absolutely thrilling, my dear ; and so romantic. The reflection of Saint Paul's Cathedral in the Dardanelles was just too, too divine. *Of course* you know where the Dardanelles are, my dear ; they connect the China Seas with the Mediterranean.

English girls are awfully attractive, though it's a shame that they have slit eyes. No comparison with Tokyo, of course, where I could have sat all day long watching the sacred elephants bathing in the Thames and the Turks prostrating themselves on the banks of the Yangtze-Kiang, chanting Philippine hymns. We saw Istanbul, the capital of India ; and I shall never forget the spires of Westminster Abbey over Karachi. Bangkok is quite the loveliest town in Japan ; but the best fun we had was in Manila. You won't believe it, my dear, but the Viceroy personally took us around the ancient harem of the Japanese sultans..."

There would be enough howlers in certain family albums to keep Bob Hope going for the rest of his days.

The airliner makes about ten stops in all ; perhaps a few too many for the modern Gulliver-in-a-hurry. When he looks at the list in a timetable, he might gather the impression that it refers to a slow-train trip instead of an ultra rapide express one.

You can bet ten-to-one that, before long, somebody will want one or more of the stops eliminated.

You never can tell. One day, maybe, the journey will be run non-stop, in which case there will be no need for the plane to land at all.

Didn't we once read something about encircling the globe like a satellite planet, overcoming the force of gravity and running very cheaply on somebody else's centrifugal force ?

Perhaps the idea isn't so ridiculous after all !

Yves Grosrichard.

The Helicopter and Stability

By Arthur M. YOUNG, Chief Development Engineer, Helicopter Division, Bell Aircraft Corp., Buffalo, N.Y.

*(Concluded)**

Part II—A New Method of Approach.

Solely as a diversion I then began some experiments with free flight of small 1/4 H.P. models. My logical approach would not entertain the possibility of such flights being impossible, and I apologised to myself for "playing with toys." Reacting from the years of effort poured into complicated configurations I had been trying heretofore, I proceeded to throw something together that was as simple as it could be made. Two-bladed co-axial rotors, shaft-driven, high-speed universal motors as power source, reduction gear, no cyclic control, constituted the simplest possible type to play with. (Fig. 3.)

However, I was due to receive a surprise —one that proved a major turning point. The model no sooner took off than it started to upset. Reluctantly I faced the conclusion that the helicopter was unstable. At first, the model wrecked itself on each flight. I then built a landing gear with long extending legs with which flights could be achieved. Previous tests had led me to decide on a two-bladed "see-saw" rotor as the simplest and most desirable. Perhaps, I reasoned, the instability was due to this particular rotor configuration. So I tried a three-bladed hinged rotor (Cierva type). The results were the same. It was the tendency of the machine to undergo violent swinging motions accompanied with each swing by an increase in amplitude, until—generally after three swings—the machine would turn over.

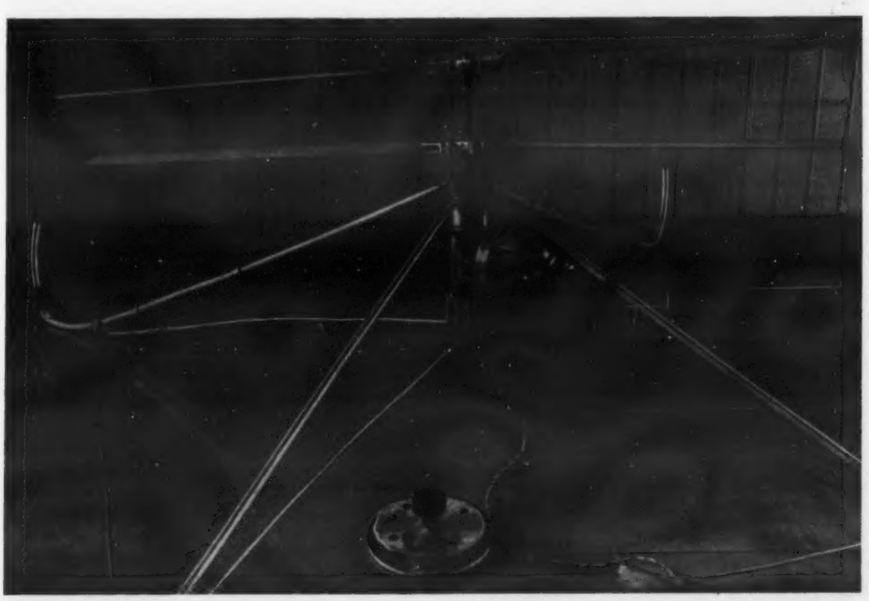
This behaviour made me start thinking in a new direction. Observing that the process was initiated by tipping rather than displacement, I proposed a theory which I called "The Persistence of Induced Flow Theory."[7] This was based on assuming the flow due to one position (say, with the rotor shaft vertical, which would result in a vertical flow of air) to persist in this direction after the machine is given an initial inclination. With such an assumption it can easily be shown by analysis of the lift vector on the two blades that the total lift vector of the rotor is so directed as to tip the mast to a still more inclined position.

The NACA investigation [8] of propellers in yaw also showed that the thrust vector on a propeller in yaw is inclined in such a direction as to further increase the angle with the wind. This work was on rigid propellers. However, the direction of force should be the same as for hinged propellers because the 90° lag due to gyroscopic effects is only present when there is no restraint due to the support.

Since the thrust for a hinged rotor must act at the rotor centre, it results in tipping the machine only because the centre of gravity of the machine is below the rotor centre. This obvious statement was one of the most difficult to realise and is of great importance, for it would then follow that if the rotor is below the centre of gravity, *the machine should be stable.* I was at a loss how to make such a test (how could a machine with the rotor beneath it make a landing ?) until I further retreated from the dignity of full-scale to make rubber band models, which could be launched from the hand. These models (Fig. 4) consisted of a tube containing rubber bands, and a shaft with rotor. The tube was restrained in rotation by a vane which could be slid along the tube to adjust total centre of pressure. Sure enough, the machine with the rotor under the centre of gravity was stable, or seemed so, for there was now no sign of oscillation.

Further experiments with these small models confirmed the phygoid instability when the centre of pressure was above the centre of gravity (Fig. 5), and also revealed

Fig. 3 Coaxial electric model.



* Cf. "INTERAVIA REVIEW" No. 6, June, 1947, P. 41-42.

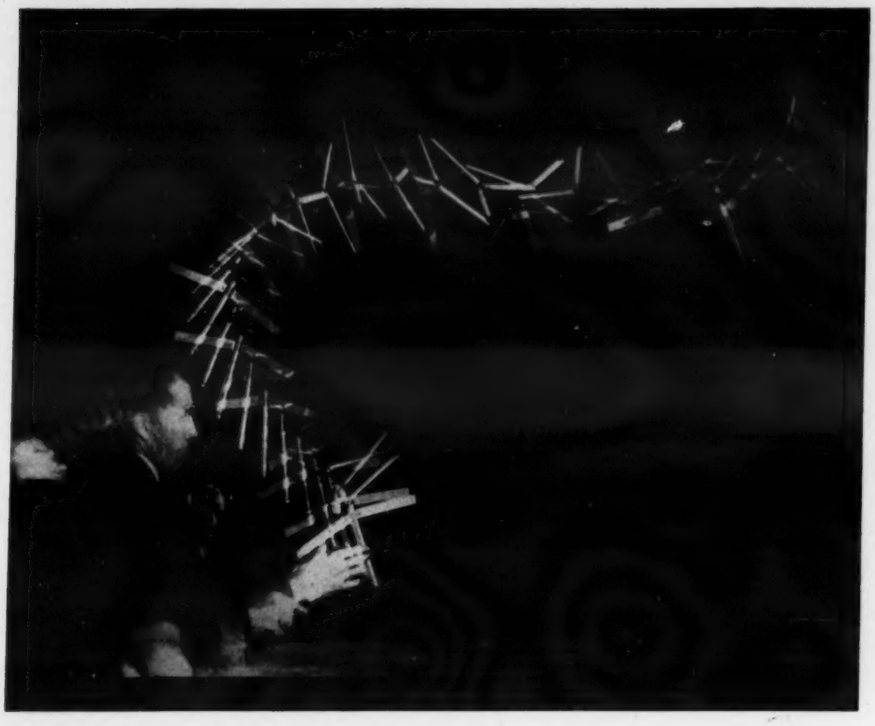


Fig. 5 : Model with rotor above the centre of gravity—flight unstable.

Fig. 7 : Stable flight with rotors balanced around the centre of gravity.

Fig. 6 : Model with rotor below the centre of gravity—flight unstable.

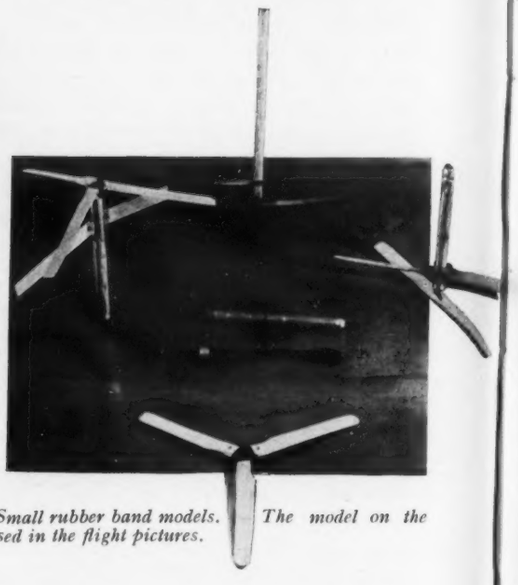


Fig. 4 : Small rubber band models. The model on the left was used in the flight pictures.

that the form with the centre of gravity below the centre of pressure had a different kind of instability. In forward flight it would gradually point itself in the direction of motion, like a dart, or a projectile, and terminate its voyage, like the dart, by plunging head first into the ground (Fig. 6). The intermediate case, when the rotor or rotors balance on the centre of gravity, has complete neutral stability at all times (Fig. 7). These two kinds of instability were discussed before the 1940 meeting of the Rotary Wing Branch of the Institute of Aeronautical Sciences,[8] and models were flown demonstrating both stable and unstable flights. It is regrettable that no paper was published, for I feel that the simple fundamental principle exhibited by this relationship of the rotor to the centre of gravity is of great importance.

Antedating my own work, but unknown to me, Hohenemser[9] had published a paper in which a method of analysis was set up which agreed perfectly with my own findings.

The photos shown, Figs. 5, 6 and 7, are of the single-hinged rotor configuration. These and others of coaxial and rigid rotor configurations were made by Gjon Mili in his studio in New York by means of the stroboscopic light that had been developed by himself and Edgerton at the Massachusetts Institute of Technology.

Simultaneous with this study of stability with small hand-launched models, efforts were being made towards finding some other solution. Obviously a helicopter with the rotor centre coinciding with the centre of gravity would be very difficult engineering-wise. It would require the rotor to rotate around the " equator " of the fuselage, and involve large diameter bearings and similar design difficulties. My first attempts to obtain stability without putting the rotor on the centre of gravity included the use of a pendulum on the swash plate. In flight this had no effect. The pendulum would swing with the fuselage, not independently of it. Other attempts were directed at

shifting the reference base for feathering from the fuselage to the rotor. This is rather hard to understand without a model, but the reader is referred to my paper before the Franklin Institute in Philadelphia, [7] November 30th, 1939, and to Kelley's paper in the SAE Journal, [4] December, 1945, and to U.S. Pat. No. 2,256,635.

This solution proved inadequate to provide true stability, although it did lengthen the period of oscillation. In passing, it is interesting to note that the parameter varied in this configuration ; the amount of blade-angle change per angle of tilt of the mast is positive, but less than 1. When this parameter is negative, the configuration used by Oehmichen [9] is obtained. Such an arrangement results in a more rapid oscillation, or conversely, if the mast is held rigidly, in less " flapping. "

In an effort to determine the effect of making this parameter greater than 1 (by a mistaken understanding of the dynamics, I thought it would produce stability), I found what I called " catastrophic instability " ; because as Eve said, when Adam asked her why she called the camel a camel, " it looked like one."

In this case the model spontaneously turned a somersault with no horizontal displacement.

Surveying the wreckage of this endeavour made me realise what was necessary. I needed a point or base which was *neither the rotor nor the mast*, with reference to which to feather the blades. This base must be independent of the mast inclination ; must not be influenced by aerodynamic forces. The inertia bar having weight and rotating with the rotor, but freely hinged on the mast so as not to partake of shifting of the mast inclination, was the result. (Fig. 8.)

With this stabilising bar and some bearing refinements, very remarkable flights were made. My model could be made to ascend, descend and ascend again over a fixed spot between the various pieces of machinery in my shop, with little or no sideways drift.

The arrangement was tried in both coaxial and single rotor versions. The mortality rate on coaxial models was high ; in bad landings the rotors were subject to hitting each other. While crackups became, with the models, part of the day's work, their greater frequency with the coaxial, and the greater extent of the damage pointed more and more to the single rotor version as a practical solution. The torque was counteracted by vanes rotated in the opposite direction to the lift rotor, which made an ideal " flying test stand " for rotors. This, in turn, gave place to correcting the torque with a small propeller on the end of the tail, turned by a separate electric motor, easily controlled from the ground through a rheostat.

My ten year ambition to obtain controlled flights was in sight. To do this, a flywheel, with uniform inertia in all horizontal directions, was substituted for the bar. To control the plane of the flywheel, the non-rotating part of the control swash plate was equipped with cone-shape plungers which dipped into elongated solenoids. The solenoids were activated by a four-way rheostat. This took care of fore and aft, and lateral cyclic control. (Fig. 9.)

Lift was varied by power input, and directional control entrusted to a small gyro connected with a vane in the rotor slipstream. This model proved quite successful and could be controlled well until its orientation wandered and confused the operator. This first model incorporated a rotating vane coaxial with the lifting rotor to correct torque. A later model (Fig. 10) incorporated improvements including an anti-torque propeller powered by a separate variable speed electric motor. With this model, designated courses could be flown, spot landings, and flights in and out of doors. (Fig. 11.) It proved a good demonstration model and exhausted the development possibilities of small models at least for a time.

A licensing agreement was then entered into with Bell Aircraft (November, 1941) for continuation of the helicopter development into full-scale machines. Approximately a year later (in December, 1942) the first full-scale machine was hovered. By summer of 1943 consistent flying at fairly high speeds had been accomplished. Many difficulties were encountered and overcome. After several years of testing and improvement, this machine evolved into the present Bell Model 47. (Fig. 12.)

One problem we encountered in full scale, that has general significance, was that created by the characteristic susceptibility of the two-bladed rotor to twice-per-revolution (aerodynamic) vibrations[5,6]. In the three-

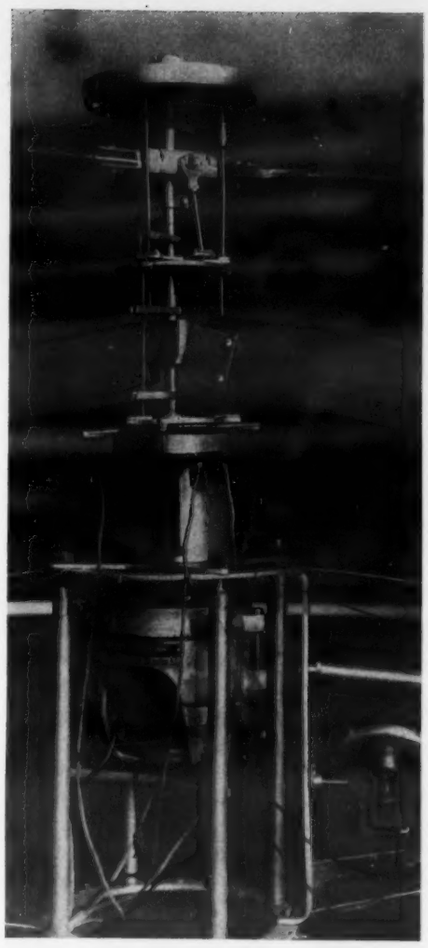


Fig. 9 : First remote-control model.

Fig. 8 : Inertia bar incorporated to stabilise model.

bladed rotor this rectified itself into a constant net drag on the rotor hub and, so hidden, did not force itself on the attention of designers of three-bladed machines such as the La Cierva autogyro and the Sikorsky helicopter.

However, with the two-bladed rotor, this force does not cancel out, and presents itself as a major problem. To explain it, we were compelled to recognise factors that had not previously been dealt with in helicopter and autogyro literature. Bennet, Sissingh and others had discussed a vertical twice-per-revolution vibration which would appear at high forward speed, but the vibration which we encountered was lateral and a maximum at low speed. The explanation[5,6] rests in the fact that the down-wash varies in velocity between front and rear of the rotor disc. The rotor hinge, or see-saw pivot, assures equal lift on the two blades, but the drag for the rearward blade increases while that for the forward blade decreases. The result is a net lateral force on the rotor hub when the blades are parallel to the flight path and vanishes when the blades are perpendicular to the flight path.

This lateral force is isolated from the machine by permitting the engine mast and rotor assembly to pivot on its centre of percussion, the spring rate for the mounting being so chosen to give a frequency lower than that of the incident forced vibration and, hence, isolate it. This method of isolating vibration differs radically from the conventional lag hinge, and avoids one fault of the latter, namely, the occurrence of so-called " ground resonance " during rev-up. We may now leave the historical outline and go into a more detailed discussion of the mechanism of the rotor and bar combination.

Part III — Stability

It was mentioned above that, prior to the recognition of the need for a stabilising device, the two-bladed see-saw rotor had been found to be a desirable simplification in rotor design. The addition of the stabiliser worked out happily with the two-bladed rotor. By placing the rotor hub on a universal joint having one set of pivots in line with the blade axis, the work done by the stabilizer bar in overcoming friction to feather the blades is reduced below what would be required if the blade feathering occurred around the pitch change bearings at the blade roots. Experiments with two and three-bladed rotors without this feature indicated greater weight required in the bar or flywheel in general.

As was noted above, the bar supplies a base with reference to which the rotor is controlled. (See Fig. 12) While it is possible to place the bar at a point further removed from the rotor, for example in the fuselage, the position near the rotor has an important advantage.

To understand this, let us think of the three elements, rotor, bar and fuselage. If the horizon is put in the fuselage, we may think of the rotor as attached to the fuselage. We want the rotor to be steered with respect to the fuselage by the same amount that the fuselage is inclined with respect to the horizon. Hence, we require a signal which measures the departure of the fuselage from horizontal to be transmitted into action to steer the rotor to that extent. A system to accomplish this will involve servo mechanisms and entail a time lag with the attendant danger of hunting.

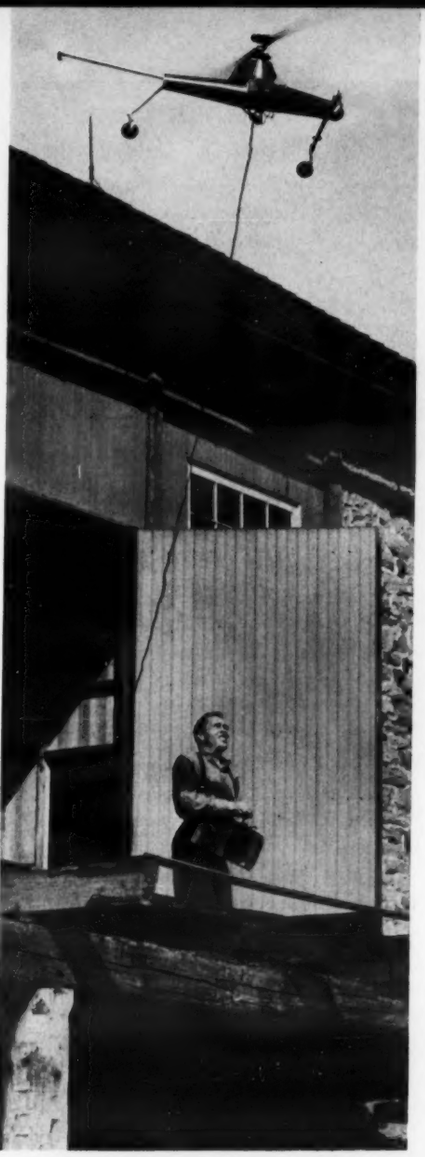
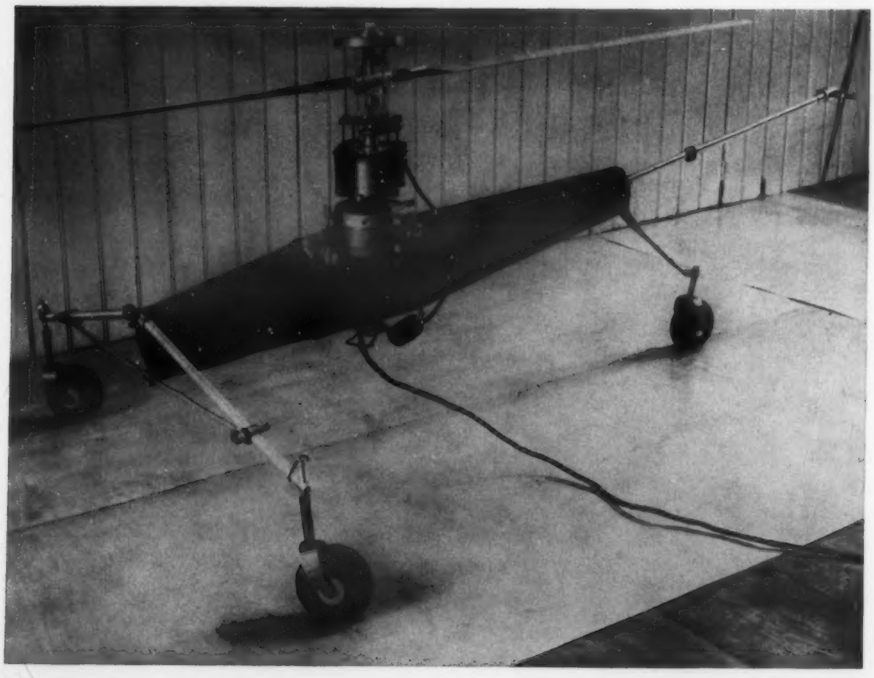


Fig. 11 : Remote-control model in flight.

Fig. 10 : Second remote-control model.



With the bar linked directly to the hub, this possibility does not occur. Instead of counteracting a change, we prevent the change from getting into the rotor at all, that is, when the mast inclines, the rotor, to the extent that it is governed by the bar, is not inclined, so we do not have to correct a displacement which did not occur in the rotor.

In the present design (Fig. 12) it will be noted that the bar, by virtue of the auxiliary levers, shares control with the pilot. In other words, tilting of the bar with respect to the mast or fuselage causes control of the rotor by feathering the blades. Tilting of the swash plate also effects this control.

The ratio of rotor tilt to bar tilt (in degrees) is known as the stability ratio. We have not found this critical since it may have values

ranging from one to one-half without pronounced differences in operation.

Another factor that affects design is friction on the bar pivots. Such friction has the effect of causing the rotating bar to tend to remain perpendicular to the driving shaft or mast. The greater the friction, the more rapidly the bar " follows " the mast. The increase of this friction will reduce the stability of the machine and increase the rapidity with which it can be manœuvred, and vice-versa. Hydraulic damper units are used to supply this friction.

Since the original design there has been practically no change in the original bar proportions. An improvement in the bar-rotor combination was obtained by placing the feathering pivot above the hub centre approximately in line with the centre of gravity of the coned blades. Recently, further improvement has been obtained by re-setting the blades in the blade grips to cause the line passing through the centre of pressure to coincide with the line through the centres of gravity.

In the Bell Model 42, the five-place helicopter now being flight-tested, a substantial reduction in the bar weights resulted in a more manœverable machine, with sufficient stability to preserve hands-off flight with forward speed. However, complete hands-off stability in hovering is not possible, even with the heavy bar, although it can be hovered about one minute without touching controls. The desirable amount of stability is largely a matter of what the pilot is used to, but it has been our experience that once a pilot has become accustomed to letting the machine take care of itself, and not continually moving the stick, the stability is a welcome improvement. This is especially true on long flights. I recall a test I made on an especially rough day with bad vertical gusts. The stick was set for 70 miles per hour and locked. The vertical gusts caused the ship to vary in altitude several hundred feet, but the variation in forward speed did not exceed plus or minus 10 miles per hour.

Not to be confused with the configuration-stability supplied by the bar are other stability effects. One, of course, is blade stability itself, which is attained by proper aerofoil shape (a symmetrical or reflex section that has zero or small c.p. movement) and balance so as to make the centre of gravity coincide with the centre of pressure. Unbalance of this kind will cause poor stick "feel," weaving or in pronounced cases, flutter. Such stability is properly referred to as blade stability, since it is confined to the blades themselves, although in extreme cases it can affect the ship. For example, if blades with considerable camber are employed at high forward speed, due to the centre of pressure's moving back at low angles of attack, the advancing blade will be subject to a diving movement.

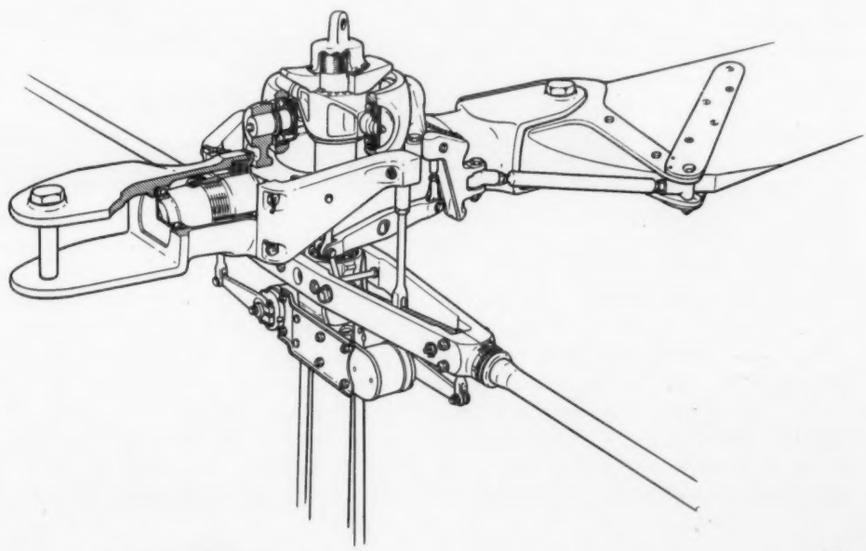
Fig. 12 : Bell Model 47.

This will transmit itself to the ship and cause it to go into a dive which may be very pronounced.

Another kind of stability may be referred to as fuselage stability. It has an important bearing on the stick gradient, or position of the stick at various forward speeds. Due to the flapping, the rotor has a modicum of inherent static stability, *i.e.*, it will incline rearwardly at high forward speed. This stabilising moment combines with the unstabilising moments due to fuselage lift and drag, and drag of the landing-gear, and other factors, to create a net moment which may be stable or unstable. Simple changes in contour, or the addition of a horizontal fin on the tail, suffice to provide a stable overall effect, and obtain the desired stick gradient.

The inherent static stability of the rotor referred to above is not to be confused with the dynamic stability supplied by the bar. Indeed, this very static stability of a flapping rotor is responsible for its dynamic instability. This can be seen in the following way. As the machine increases its forward speed, flapping increases. Hence, it creates a moment which tends to reduce forward speed and it is therefore a statically stable moment. In a machine without a bar this would be well and good if the machine were just a rotor, but there is a pendulate fuselage hanging from the rotor and governing its position through the swash plate. So what happens ? As the rotor tips back in response to the increased speed, it puts a force on the top of the mast which tips the fuselage back. Since the swash plate tips back with the fuselage, the rotor is tipped still further. This causes still greater tipping of the fuselage and we have what is the beginning of phygoid oscillation or " porpoising."

Fig. 13 : Line-drawing of hub and bar assembly.



On the other hand, with the stabiliser bar, the rotor position is relatively independent of mast inclination, so their interaction does not result in further tipping.

In conclusion, it is possible to make an interesting generality on the subject of stability.

In dynamic systems without damping, there is only one true stability, namely, neutral stability. This is found midway along the spectrum which runs from divergence at one end to oscillation at the other.

A sphere rolling on a flat surface exhibits neutral stability ; on a convex surface or hill it exhibits divergence, *i.e.*, it tends to roll on one side ; in a concave bowl it rolls back and forth. The latter is sometimes called static stability, but in dynamic systems subject to interaction between elements, this state can, by absorbing energy, build up large amplitudes. Flutter in helicopter blades is another example of the overall instability which results when the rotor is above the centre of gravity. When the rotor is below the centre of gravity, we have, of course, the divergence phenomenon. With blades we may also have the divergence phenomenon manifested in a disguised form due to control stiffness.

In this connection developments in the quantum theory are comparable. The Schroedinger equation exhibits these two states : that which holds when the election is at a distance from the nucleus so that it tends to fall toward it, and that which holds when it is oscillating around the nucleus.

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Monocoque Construction

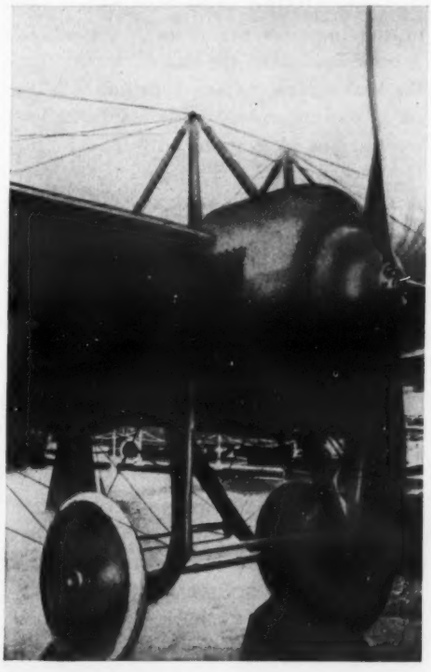
By N. J. Hoff, Professor of Aeronautical Engineering, Polytechnic Institute of Brooklyn

1. *Thin-Walled Monocoques*

Perhaps the most significant fact in the structural design of aeroplanes is that the structures expert must pay as much attention to the aerodynamic requirements as to structural efficiency. For this reason it is senseless to speak of any type of aeroplane structure as the best. There can only be a best solution of the design problem for a given high speed. This point is illustrated by the fact that structures developed in earlier stages of aviation could be employed successfully at a later date in planes of comparable high speed. For instance the framework fuselage of the '20s, and particularly the welded steel tube framework popularised by Anthony Fokker, still represents the best solution of the design problem of the fuselage of private planes and trainers in the 100 mile per hour maximum speed range.

As the high speed of the aeroplane increased, the framework became unsatisfactory and was replaced by another structural arrangement known as monocoque construction. The word is a hybrid combination of the Greek word "monos" meaning single and the French word "coque" meaning shell. It was the name given to the model constructed in France in 1912 by Deperdussin according to the plans of Bechereau. This early forerunner of today's most popular design had a fuselage consisting of a single shell constructed of three layers of tulip wood, each about 1/16 in. thick, glued on a mold to form a streamlined shape. Its forward portion was covered with a chromium nickel steel plate of approximately 1/16 in. thickness which protected the engine and pilot.

Fig. 1: Deperdussin Monocoque. (1912 Jahrbuch der Luftfahrt, by A. Vorreiter.)



When the development of the modern monocoque transport plane began in the United States in the late '20s, the basic idea of the Deperdussin monocoque was revived. The fuselages of the new monocoques consisted of a single shell able to perform the dual duties of housing the crew, passengers and cargo in a smooth, streamlined body, and of transmitting and resisting all the forces imposed upon the fuselage by the loads acting upon the tail during flight and at landing. In the framework fuselage these two duties were performed by two separate elements. The loads were carried by a framework resembling the framed structure of steel bridges while the external shape was provided by a fabric covering applied either directly to the framework or to lightweight formers attached to the framework. Since the fabric covering sags between the formers or ribs to which it is sewed, it cannot provide as accurate a shape as the wooden or metal monocoque does. Fabric is entirely unsuited to the construction of doubly-curved surfaces such as those found at the intersection of the wing with the fuselage. For this reason the aerodynamic properties of the monocoque are superior to those of fabric-covered framed structures.

Another advantage of the monocoque may be seen from Fig. 2. The solid lines represent the smallest rectangular framework fuselage that can enclose the two persons shown seated. The dotted line indicates the fabric-covered superstructure attached to the framework to give a streamlined shape. It is apparent that there is much waste space in the corners and that the total cross-sectional area is much greater than the part utilised. Yet the drag of the fuselage is proportional to the total cross-sectional area which must be kept to a minimum if the highest possible speed is to be achieved. The advantage of the monocoque is obvious when the area enclosed by the dash-dotted line representing the monocoque shell is compared with the dotted line which shows the contour of the streamlined framework. In the figure the area of the monocoque is only two-thirds that of the streamlined framework fuselage.

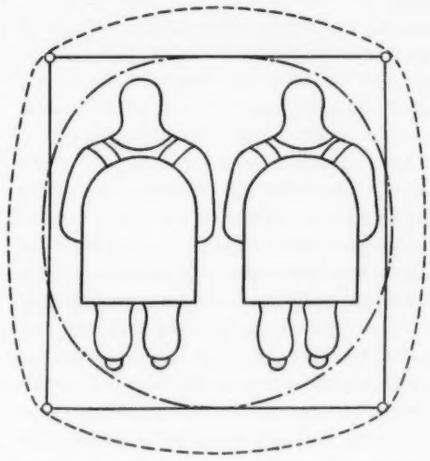


Fig. 2: Comparison of Framework and Monocoque Fuselages.

The wings of the new type transports were also contructed according to the monocoque principle. They consisted of a metal skin reinforced with longitudinal stiffeners, known as stringers or cap strips, and transversely arranged frames or ribs. The use of fabric for the covering was restricted to ailerons and tail surfaces. During World War II even this restricted use of fabric was abandoned since the high local pressure and suction forces in the neighbourhood of the leading edge of the moveable surfaces caused unpermissible changes in shape. Cases had been known where the aerodynamic forces due to the deformation of the fabric covering had

caused dangerous vibrations and led to a loss of control.

The replacement of the fabric-covered framed structure by the monocoque was thus a consequence of the designer's demand for increased aerodynamic efficiency. The structures expert had to devise an arrangement that could give a reasonable strength-to-weight ratio and would be acceptable to the production man. A small penalty in weight was considered acceptable in exchange for the better aerodynamic properties, but it could not be excessive because of the great importance of weight in aeroplane construction. Wood did not become a favoured structural material for the monocoque probably for two reasons. First, the stress analyst was not well enough acquainted with its properties, disliked the variation in its strength and elasticity with direction, specific gravity and moisture, and distrusted it because of the possibilities of failure due to pitch pockets, knots and incorrect kiln drying. Secondly, the production man, who was asked to rationalise aeroplane production, came from industries in which metal alone was used and was conversant only with metal manufacture. Consequently most of the monocoques built in the '30s were constructed of aluminium alloys. However, great obstacles had to be overcome before the metal monocoque was successful.

The fundamental difficulty arose from the fact that aeroplane structures are very lightly loaded while their cross-sectional dimensions are reasonably large. A quantitative expression of this qualitative statement is available in the index $\sqrt{W/h}$. W is the load, for instance a shear force transmitted by the fuselage, and h is a representative cross-sectional dimension, for example the diameter of the fuselage. Because of the small loads to be transmitted, little cross-sectional area is needed when a high-strength material such as heat-treated aluminium alloy is used. The small cross-sectional area spread over a large circumference results in structural elements which are extremely thin and slender. Such elements, however, become unstable under very light loads and therefore the high strength of the metal is inadequately utilised and the strength-to-weight ratio of the structure is poor. For example the critical stress under which the surface of a thin-walled circular cylinder buckles into a multi-lobed pattern is given by the formula

$$f_{cr} = 0.3\ E\ (t/r)$$

where f_{cr} is the critical stress, E Young's modulus of the material, t the wall thickness of the cylinder and r its radius.

The significance of this formula can be understood from a numerical example. The fuselage of a large, present-day transport plane may have a diameter of 10 ft. and the thickness of its sheet covering is likely to be about 0.032 in. With Young's modulus for

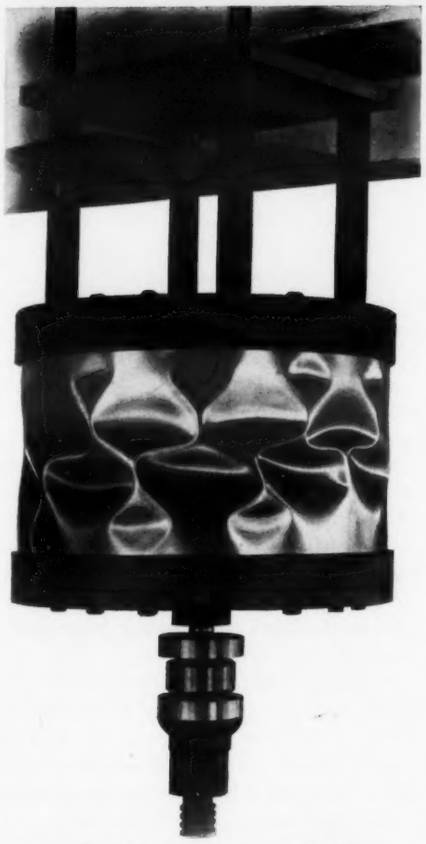


Fig. 3: Multi-lobed Pattern of Buckling as shown by E. E. Lundquist's Tests. (Courtesy of National Advisory Committee for Aeronautics.)

aluminium alloy $E = 10.5 \times 10^6$ lbs. per sq. in. substitution into the formula yields $f_{cr} =$ 840 lbs. per sq. in. If this critical stress value is compared with the ultimate stress of aluminium alloy, which is about 62,000 lbs. per sq. in., it is obvious that a thin shell by itself is entirely unsuitable for an aeroplane fuselage. It would have to be made very thick and consequently prohibitively heavy in order to ensure that it can safely carry the loads imposed upon it in flight and at landing.

A suitable structure is obtained, however, if the thin shell is reinforced both longitudinally and transversely by stiffeners. In such a reinforced monocoque structure the stiffening elements remain stable up to values of the compressive stress comparable to the yield point stress of the material. On the other hand the addition of stiffeners does not materially change the buckling stress of the sheet covering itself. Consequently the panels of the sheet between the stiffeners are in a buckled state long before the longitudinal reinforcing elements reach the limit of their load-carrying capacity.

The fundamental principle upon which thin-walled reinforced monocoque design rests is the possibility of employing thin sheet in a buckled, wrinkled state for load-carrying purposes. Before monocoque construction was adopted by the aeroplane industry, around 1930, it was generally believed that buckling was equivalent to failure. In structural engineering adequate safety factors were prescribed in order to keep the stresses well below those corresponding to instability. In present-day aeroplane construction it is considered permissible to subject a fuselage in flight to a bending moment which is ten or twenty times as large as the bending moment under which the thin sheet covering becomes wavy. When the bending moment is removed the wrinkles vanish, and the surface of the fuselage regains its smooth shape provided that the stresses accompanying wrinkling are within the elastic limit of the material. From the structural standpoint no objections can be raised to the development of wrinkles during flight, although the aerodynamicist may object to such a deterioration of the surface of the aeroplane.

The earlier idea that buckling was equivalent to failure was disproved in tests carried out by L. Schuman and G. Back at the National Bureau of Standards, Washington, D.C., in 1930. Thin rectangular panels of aluminium alloy, stainless steel, nickel and monel metal were subjected to uniform edgewise compression on a conventional testing machine while the unloaded edges of the panel were supported in V grooves. The panels buckled at values of the critical stress approximately equal to those predicted by the theoretical formula

$$f_{cr} = kE(t/b)^2$$

where f_{cr} is the critical compressive stress, E is Young's modulus, t is the thickness of the sheet, b the width between the V groove supports, and k a numerical factor depending upon the side ratio of the panel and equal to 3.62 when the panel is square. Schuman and Back observed that when the moveable head of the machine was lowered beyond the position reached at the moment of buckling, the load reading increased instead of falling off as was anticipated. The maximum load reached was often from ten to thirty times the buckling load and was practically independent of the width of the panel. A physical

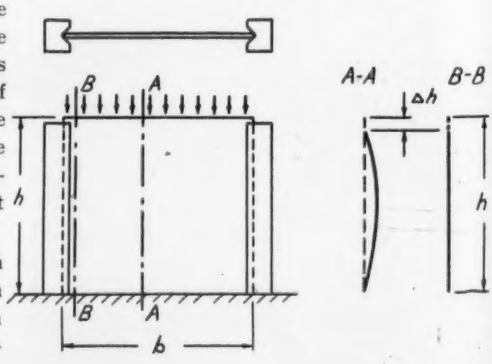


Fig. 4: Deformations of Flat Rectangular Plate after Buckling.

explanation of the unexpected behaviour was given by the two investigators after consultation with W. R. Osgood, also of the National Bureau of Standards. A mathematical analysis was presented by Th. von Kármán in 1932.

When the critical stress is reached and a bulge develops in the middle of a square panel any further displacement of the upper edge of the panel results only in an increased bowing of the fibres in the middle of the panel and in no substantial change in the average compressive stress they carry. On the other hand the fibres adjacent to the V groove cannot deflect and thus they must shorten when the upper platen of the testing machine is lowered. In these fibres, therefore, the shortening of the distance between the upper and lower edges is equivalent to a corresponding increase in compressive strain and hence in compressive stress. The uniformity of the stress distribution in the panel thus no longer exists when the moveable head of the testing machine is kept in motion after the buckling load is reached. In the middle of the panel the compressive stress remains substantially the same as its value at the moment of buckling, while in the edges of the panel the stress is increased considerably. Failure occurs when the edge stress becomes equal to the yield point stress of the material. When the yield stress is a multiple of the critical stress, the load applied to the panel is carried almost entirely in two narrow strips adjacent to the unloaded edges.

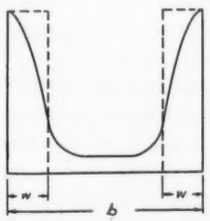


Fig. 5: Stresses in Flat Rectangular Plate after Buckling. (The full line represents the actual stress distribution and the dotted lines the imaginary distribution according to the effective width theory.)

The formula developed by Th. von Kármán is

$$2w = 1.9\,t\,\sqrt{E/f_{up}}$$

where t is the thickness of the sheet, E Young's modulus of the material, f_{up} its yield point stress, and $2w$ is denoted as the effective width of the sheet. The effective width is defined as the imaginary width that would carry the same load when subjected to the yield point stress as the load actually supported by the entire panel at the moment of failure. It may be seen that the effective width is independent of the total width of the panel. It is approximately equal to thirty times the thickness of the panel when the material is one of the commonly-used aluminium alloys.

In the case of aluminium alloy having a yield point stress of 40,000 lbs. per sq. in. the von Kármán formula gives $2w = 30.8t$, that is for 0.032 in. thick sheet an effective width of 0.985 in. Since, according to the assumptions, this effective width of sheet is subjected to the yield point stress at the moment of failure, the ultimate load carried is equal to $0.985 \times 0.032 \times 40{,}000 = 1{,}260$ lbs. per sq. in. On the other hand the buckling stress calculated from the flat plate buckling formula for an 8 in. wide panel of aluminium alloy of 0.032 in. thickness is $3.62 \times 10.5 \times 10^6 \times (0.032/8)^2 = 607$ lbs. per sq. in. Hence the load carried by the plate at the moment of buckling is $607 \times 8 \times 0.032 = 155$ lbs. The numerical example shows how great the difference is between the buckling load and the load at failure. This difference cannot be ignored by the aeronautical engineer when he is trying to design the lightest possible structure.

The possibility of using, for structural purposes, a thin sheet that wrinkles under the action of the shear force it transmits was demonstrated by H. Wagner around 1929 while working for the designer A. Rohrbach. The wrinkled sheet soon became a generally-accepted structural element, and beams utilising it were denoted as Wagner beams. In its simplest form the Wagner beam is a plate girder having a very thin web reinforced by closely spaced uprights. When the transverse loading of the beam is applied, the thin web buckles and develops diagonal folds. After buckling no stresses can be transmitted across the folds, but in the direction of the folds the sheet is still capable of

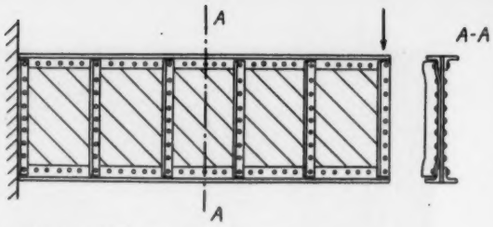


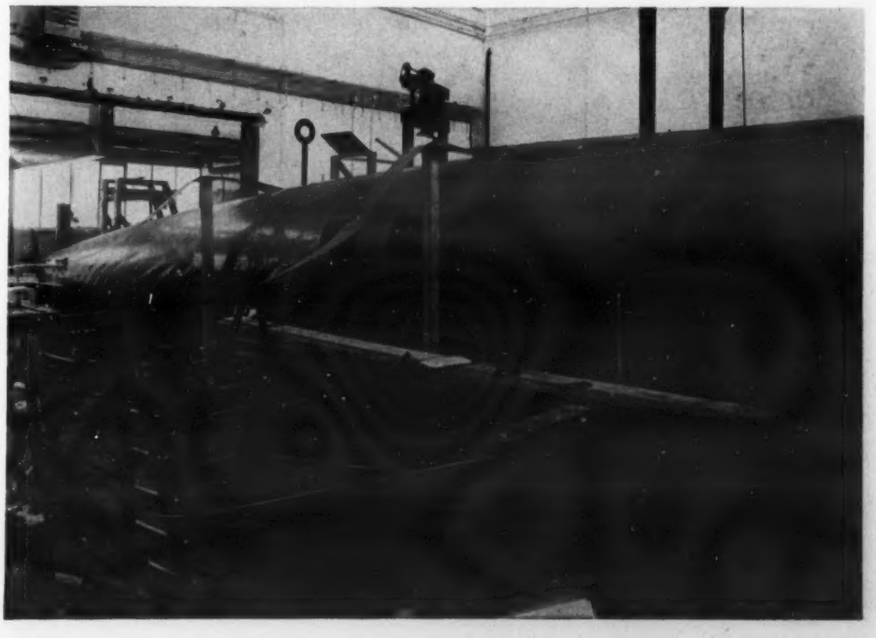
Fig. 6: Wagner Beam.

carrying high tensile stresses. As a matter of fact the web of the Wagner beam acts more or less like an assembly of closely-spaced strings connecting the upper and lower flanges and running in the direction of the folds. In the case of a monocoque-type fuselage the reinforcing rings take the place of the uprights and the skin of the fuselage acts as the web and develops diagonal folds very much like those observed in the web of the Wagner beam. Fig. 7 is a photograph of the fuselage of the Heinkel He-111 bomber undergoing a static test. The diagonal folds are clearly visible in the picture.

It was Wagner's contribution to structural engineering to have noticed that the buckling of the web does not mean the end of the load-carrying capacity of a beam provided that the web is made of very thin sheet. He developed an efficient light-weight design and showed how the stress distribution in, and the load carrying capacity of, the Wagner beam can be calculated with an accuracy sufficient for engineering purposes. Tests proved that many Wagner beams can support loads fifty or even a hundred times greater than under which the first folds develop.

According to the ideas prevalent in the middle '30s the best monocoque design concentrated the greatest amount of material

Fig. 7: Static Test of Heinkel He-111 Fuselage. (Courtesy of Ernst Heinkel Flugzeugwerke.)



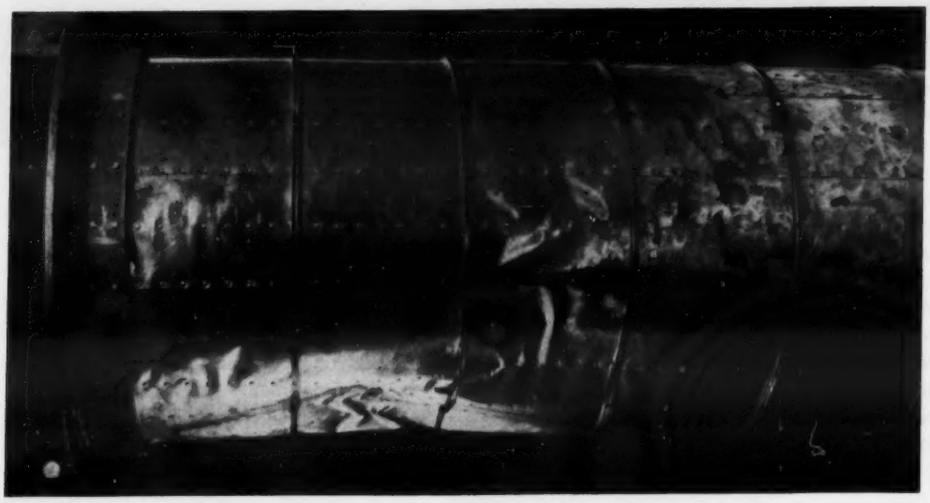


Fig. 9: General Instability of Reinforced Monocoque Cylinder.

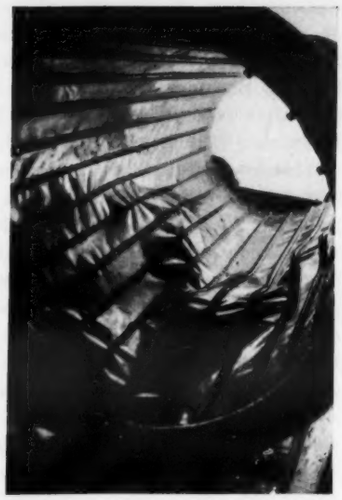


Fig. 10: Inside View of Reinforced Monocoque Cylinder after Failure according to General Instability Pattern.

in the stringers and had a sheet covering of the lightest gauge available. The reason is simple. Since the stress in the middle of a buckled panel of sheet is always considerably lower than the stress near the edges, the material of the sheet can never be as efficiently used as that of the stringers. Consequently, the best load-to-weight ratio can be obtained in a structure in which as little material is allotted to the sheet covering as possible. The only disadvantage of designing aeroplanes according to this principle is the early buckling or wrinkling of the sheet covering. When the sheet is inside the wing or the fuselage, as for instance in the case of Wagner type wing spars, no objection can be raised to such wrinkling. When the sheet forms the outer covering, however, the wrinkles disturb the airflow and cause additional drag, thus slowing down the aeroplane. This effect became important in the late '30s with the consequence that the designers tried to counteract the wrinkling tendency.

The first remedy was the use of more closely spaced stringers. Although the effect of the stringer spacing upon the buckling stress is slight, at least the wrinkles remain shallow when the panel is small. This is already a substantial gain from the aerodynamic standpoint. However, the decrease in the stringer spacing means the use of an increased number of stringers. In order to keep the total weight constant the cross-sectional area of each stringer must be made smaller. But a smaller section stringer buckles under a smaller load, as may be seen from the well-known formula established in 1743 by the mathematician Euler of Basle, Switzerland :

$$P_{cr} = \frac{\pi^2 EI}{L^2}$$

In this equation P_{cr} is the load under which the column buckles, E is Young's modulus of the material, I the moment of inertia of the cross section of the column, and L the length of the column.

The Euler formula indicates that the easiest way to counteract the loss in the load-carrying capacity of the stringers is to decrease the length of the column. This means that the rings which act as supports for the columns must be more closely spaced. Again this leads to the choice of lighter rings in order to keep the total weight of the now more numerous rings unchanged.

When the rings are made lighter and lighter, and consequently weaker and weaker, a stage will eventually be reached when the bending rigidity of the rings no longer suffices to support the stringers rigidly. Then the rings give at the moment the stringers buckle. This type of buckling, in which several stringers and rings are simultaneously involved, is known as the general instability of a reinforced monocoque cylinder. Fig. 9 is a photograph of a test cylinder that failed in general instability and Fig. 10 is an inside view of the same cylinder. The test specimen was built with the rings on the outside and the stringers on the inside of the sheet, because this construction is much cheaper than the one used in actual aeroplanes where all the reinforcing elements are inside. The more expensive construction is of course necessary in aeroplanes in order to keep the surface smooth, while in static

Fig. 8: Inside View of Boeing YC-97 "Stratofreighter." (Courtesy of Boeing Aircraft Co.)

tests the aerodynamic requirements can be disregarded.

In 1938 the writer established theoretically a buckling index which can be used to predict whether a monocoque cylinder will fail in general instability or by the buckling of its stringers between rings. The buckling index is a non-dimensional parameter defined as

$$\Lambda = \frac{r^4}{L_1^3 d} \frac{(EI)_{str}}{(EI)_r}$$

where Λ is the buckling index, r the radius of the cylinder, L_1 the distance between adjacent rings, d the distance between adjacent stringers, $(EI)_{str}$ the bending rigidity of a stringer and $(EI)_r$ the bending rigidity of a ring. Experiments carried out in the Guggenheim Aeronautics Laboratory of the California Institute of Technology (GALCIT) and in the Polytechnic Institute of Brooklyn Aeronautical Laboratories (PIBAL) under the sponsorship of the Civil Aeronautics Administration (CAA) and the National Advisory Committee for Aeronautics (NACA) proved that when the buckling index is smaller than 20 instability will occur through the buckling of the stringers between the rings. This type of failure is designated as panel instability. When the index is greater than 80 buckling will occur according to the general instability pattern. Finally, when the index has values between the two limits quoted, either type of instability is possible.

The buckling index provides the designer with a convenient method of checking the type of instability that can be expected with any given design. It is advisable to choose the dimensions of the different structural elements of the monocoque cylinder in such a manner as to obtain a buckling index value in the transition zone. Such a structure has the best strength-to-weight ratio because it offers an approximately equal resistance to panel-type buckling and general instability. When a change in the value of the buckling index is desired in practical design the simplest procedure is to alter the distance between adjacent rings or the bending rigidity of the rings. For instance if Λ is found to be 1 in a particular design then the rings are too strong, they are spaced too far apart, or the stringers are too weak. In any case the bending rigidity of the rings cannot be utilised fully to prevent general instability because the stringers buckle between adjacent rings under comparatively low loads. By spacing the rings closer the value of the buckling index can be raised and the buckling load according to panel-type instability increased until a better structural efficiency is reached. On the other hand when the value of the buckling index is, for example, 200, then the cylinder will fail in general instability at a much lower stress than would cause panel-type buckling. In such a case it is worth while to increase the bending rigidity of the rings with a consequent decrease in the value of the buckling index below 80. This added rigidity of the rings increases the buckling stress in general instability and brings it closer to the stress at which the stringers buckle according to the panel instability pattern.

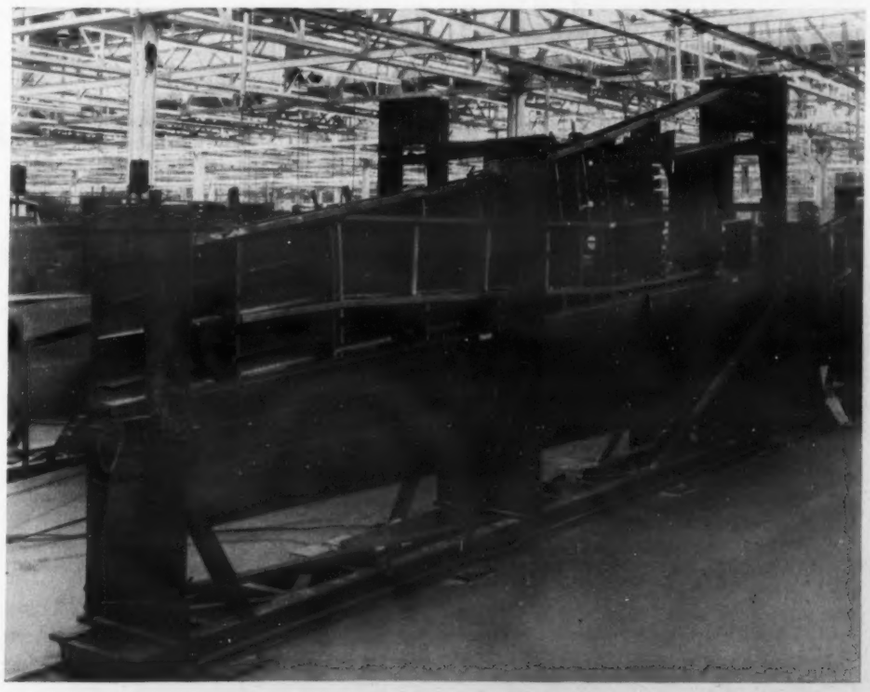
It may be seen from the equation defining the buckling index that large values of the index are most likely to be reached when the radius of the reinforced monocoque cylinder is large. Indeed a survey of available data disclosed that the comparatively small-size fuselages used in transport planes before World War II had buckling indices smaller than 1, while the recently-constructed giant airliners have reinforced monocoque fuselages of which the indices fall into the transition zone. This shows that sufficient rigidity to prevent general instability may become a problem in the future when fuselages are constructed with diameters larger than those used today.

When, in the course of the development of the thin-walled monocoque, the theoretical and experimental data just discussed became known, the aeronautical engineer was able to design thin-walled monocoque wings and fuselages just as reliably as the framed structures of the '20s. Nevertheless, many planes flying today are not built according to the true reinforced monocoque principle. The reason for deviating from this principle is the necessity of providing large cut-outs in the structure. The cut-outs have comparatively little effect in the fuselages of passenger transports, in which the disturbance of the flow of force caused by the small windows and doors is almost negligible. The situation is different in planes designed to accommodate bulky cargo, and in bombers provided with large bomb-doors and blisters for gun-mounts.

Fig. 12: Wing Rib of Douglas DC-4 (Courtesy of Douglas Aircraft Co.)

The most critical condition exists in the wings, particularly the wings of fighter planes. There, a considerable portion of the load-carrying reinforced sheet covering must be cut out in order to permit the retraction of the landing-gear and to provide space for fuel tanks. To make things worse these cut-outs are situated near the root of the wing, where the loads are highest. To compensate for the loss of the reinforced sheet, strong individual members have to be introduced, with the consequence that this portion of the wing is generally not very different from the two-spar construction of the framed structures of the preceding era. The bending moment is carried mainly by two spars and the purpose of the reinforced

Fig. 11: Wing Assembly of Curtiss P-40. (Courtesy of Curtiss-Wright Corp.)



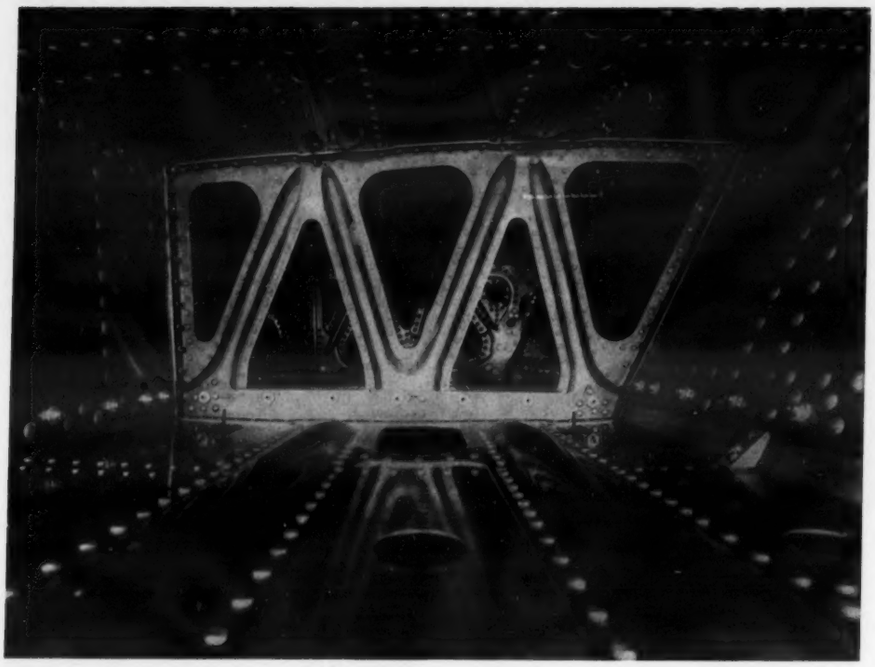


Fig. 13: Inside View of Wing of Grumman "Hellcat." (Courtesy of Grumman Aircraft Engineering Corp.)

sheet covering is fundamentally that of transmitting the shear forces, particularly those caused by torsion. Near the wing-tip, true reinforced monocoque construction is possible; but between wing-tip and wing-root, full utilisation of the reinforced sheet covering is prevented by the engine installations of multi-engined aeroplanes. An additional difficulty arises in carrier-borne fighters, where large concentrated loads are introduced into the wing structure at the hinges of the folding wings.

Similar concentrated load and cut-out effects often induce the aeronautical engineer to design the forward portion of the fuselage with four main longerons. The rear portion of the fuselage of modern transport planes is, however, generally constructed according to the true reinforced monocoque principle.

In conclusion it may be stated that the aerodynamic requirement of a smooth streamlined surface resulted in a general adoption of the thin-walled monocoque construction in the wings and fuselages of the modern aeroplane. Whenever feasible, the sheet covering and its longitudinal reinforcing elements are fully utilised to carry the normal stresses caused by the bending moments. In regions where large cut-outs disrupt the continuity of sheet and stringers, the designer has to rely upon longerons and spars to transmit the bending moment, and he can utilise the sheet covering only to take care of the shear loads. Thin-walled monocoque construction has proved successful in the design of high-speed transport and military aeroplanes. However, the advances made during World War II in the fields of propulsion and aerodynamics necessitate further improvements in streamlining and surface smoothness. The means by which such improvements can be achieved will be discussed in the second part of this article.

(To be concluded next month.)

Full-Span Flap and Aileron Combinations

By Dr. Alexander KLEMIN, New York

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INTRODUCTION

As loadings per square foot and landing speeds increase, airplane designers want to obtain the maximum in lift increase by using full-span flaps while seeking to retain satisfactory lateral control. The purpose of this article is to review the extensive National Advisory Committee for Aeronautics research on full-span flap and aileron combinations and to offer qualitative recommendations. The NACA study of the full-span flap aileron combinations is part of a comprehensive research on lateral control which began in 1931.

WHAT FLAP TO USE

Engineers have long worked on many different lift increase devices, though they have now narrowed their choice to one or two forms. In the United States they have never seriously considered the Handley Page slot. They find little to choose between the plain slotted flap and the split flap in lift increase, but prefer the slotted flap because it is more efficient in take-off. The Fowler flap which is an auxiliary surface extended back from the main wing is aerodynamically sound, but produces a large and undesirable pitching moment and has not been widely used. The double slotted flap, with a width 40 per cent of the chord of its wing, can increase the maximum lift of the NACA 23021 airfoil by the enormous figure of 162 per cent, but a double slotted flap suffers from complexity besides the same difficulty of large pitching moment. For the most part constructors keep to the plain slotted flap, and wind tunnel workers at Langley Field have accordingly given most attention to controls for the plain slotted flap. We shall follow their example.

WHAT CONSTITUTES SATISFACTORY LATERAL CONTROL ?

For the purpose of this article it is not necessary to define the qualities of a good flap, but it is to list the requirements of satisfactory lateral control :

1. The rolling moment coefficient should increase with the lift coefficient—whether the lift increase is due to change in angle of attack or to flap deflection. Only thus will the response to lateral control be the same irrespective of altitude or speed.

2. Weick and Jones (Ref. 1) state that the rolling criterion

$$RC = \frac{C_l}{C_L} = \frac{\textit{rolling moment coefficient}}{\textit{lift coefficient}}$$

should not, if possible, fall below 0.075, although stick forces may force compromise to a lower value. The same authors give an interesting alternative criterion : in a small two-seater personal plane, a satisfactory control should give 15° bank in one second, with flap deflected to give a high lift coefficient.

3. Gilruth and Turner (Ref. 2) give still another, a more modern, less conservative expression for aileron effectiveness :

$$\frac{pb}{2V} \geq 0.07$$

Where p is the angular velocity in roll in radions/second produced by application of the ailerons, b is the span in feet and V the forward speed in f.p.s. This criterion is more logical because it is based on speed which is apparent to the pilot, and not on the lift coefficient which is not.

4. It is not sufficient to have high maximum values of $\frac{pb}{2V}$. The pilot also likes to feel that the effectiveness should vary smoothly with the deflection of the control device. It is also important that there be no range of low effectiveness for small aileron or spoiler deflections.

5. There should be no lag in rolling response to lateral control. Spahr (Ref. 4) states that the time required for establishing maximum acceleration after abrupt deflection of controls should be less than 0.2 second or $\frac{37.5\bar{c}}{V}$ where $\bar{c}$ = mean aerodynamic chord.

6. Shortal (Ref. 5) defines lag in another way as the time before a rolling motion is imparted to the wing and states that this lag should not be more than 0.1 second.

7. An alternative way of defining the regular variation of control is to say that C_l should increase linearly with δ_a, and that the slope $dC_l/d\delta_a$ should be large for small deflections to give the pilot a sensation of ready response.

8. Nothing is so likely to distress the pilot and to lead to over-control as an initial reversal of the rolling moment for small displacements of the aileron or spoiler. Initial reversal is taboo.

9. The hinge moments of lateral control devices should not produce excessively heavy stick or wheel forces, but they should not be so small as to deprive the pilot of a " centring " feel. Control forces should increase steadily with aileron displacement, and there should be no irregularity or reversal at small displacement angles.

10. The hinge moments of one aileron should if possible counter-balance the hinge moments of the other. When the control on only one wing is moved at a time (as with external ailerons and spoilers) it is no longer possible to balance hinge moments by interconnection of surfaces. Signs and magnitudes of hinge moments then have greater importance than with conventional ailerons.

11. Since hydraulic or electric boosting is still not universal, control devices should lend themselves to aerodynamic boosting or balancing as with tabs.

12. C_N, the yawing moment coefficient due to aileron application, should be " favourable, " which means that the yawing moment due to the ailerons should work in conjunction with the rolling moment to produce a turn. If the yawing moment is adverse, then it should be small.

13. Lateral control devices should be effective at or near the stall, or in inverted flight.

14. They should not introduce such local pitching moments as to twist the wing and thereby reduce control effectiveness.

15. Finally, the control device should be well adapted to the full-span flap. The control should permit the flap to realise the maximum in lift increase, and the deflection of the flap should not change the rolling moment characteristics of the control—except as warranted by an increase in lift coefficient.

There are many other things that a designer will consider, such as mechanical complexity and weight, besides the aerodynamic factors just listed.

THE CRITERION OF AILERON EFFECTIVENESS

The criterion of aileron effectiveness $\frac{pb}{2V} > .07$ applies to private planes, pursuits, bombers, every type of aircraft, irrespective of size, though small military aircraft will naturally have greater values for this coefficient.

It is not convenient to determine this coefficient by elaborate rolling experiments in the wind tunnel, but it is possible to calculate it from static experiments with the aid of the formula

$$\frac{pb}{2V} = \frac{C_l}{C_{lp}}$$

where C_{lp} is the coefficient of damping in roll. The value of C_{lp} is obtained from wind tunnel tests, while C_{lp} can be calculated by simple strip theory (Ref. 3), taking into account the differences in angle of attack on either side of the wing which are produced by a steady rolling velocity.

Aileron effectiveness developed in flight may be considerably less than that indicated by calculations of $\frac{pb}{2V}$ from theory and tunnel tests. Wing twist and deflection may rob the ailerons of much of their power. Other considerations enter into satisfactory lateral control, but the value of $\frac{pb}{2V}$ is a primary measure of effectiveness.

Flight test procedure in determining this ratio is now fairly standard (Ref. 6). The

Two-seater Fairchild F 22 powered with 145-H.P. Warner " Super Scarab, " used for test flights with A 1 aileron combination.

pilot trims all control forces to zero in straight level flight at a predetermined speed. Very abruptly he moves the aileron control to a deflection set by a stop, while holding the rudder fixed in its trim position. He allows the roll to progress until after maximum rolling velocity has been reached, without further movement of any control. The pilot then recovers from the manœuvre in any way he wants to and repeats tests with various aileron deflections. In addition to airspeed measurements and the like, p_{max}, the rolling moment velocity ; δ_a, the aileron deflection ; and the stick forces are measured. Data are evaluated to obtain the important coefficient $\frac{pb}{2V}$ with appropriate graphs.

TWO GROUPS OF DEVICES

We shall now examine outstanding devices. Strictly chronological order is difficult, because technical development never proceeds in chronological order. But we can classify these devices into two groups :

A. A Group of Early Lateral Controls

1. Retractable Split Flap with Conventional Ailerons
2. Auxiliary Surface Ailerons
3. External Ailerons
4. Upper Surface Ailerons
5. Hinged Flap Spoilers
6. Flap Type Deflectors
7. Some Combinations.

B. A Group of More Modern Lateral Controls

1. Retractable Ailerons or Spoilers
2. Curved Plate Retractable Ailerons
3. Retractable Ailerons with Guide Ailerons (P-61)
4. Plug-Type Spoiler-Slot Aileron
5. Slot-Lip Ailerons
6. Trailing Edge Flaps in Rear of Main Flaps
7. Trailing Edge Ailerons and Slot-Lip Ailerons Combined
8. Flight Tests of a Variety of Spoilers (Northrop P-61A)

A. A GROUP OF EARLY LATERAL CONTROLS

A1 – Retractable Split Flap with Conventional Ailerons

(References 1, 7, 8). Fig. 1 indicates the most typical installation as described in Ref. 7. The split flap retracts upward and forward, and is so located that it does not interfere with operation of conventional narrow chord ailerons. To compensate for its smaller chord the aileron is given large differential action (up 25° and down 14°). In wind tunnel test the control had little lag, and the adverse yawing moments were no greater than for entirely conventional ailerons. The yawing characteristics at a given lift coefficient were *less* unfavourable with the flaps deflected than with the flaps retracted, and the rolling criterion C_l/C_L was practically the same flap down or flap retracted, in spite of shielding. (Elsewhere it is reported that some improvement can be obtained if a gap is left between the nose of the deflected flap and the lower surface of the wing.) The control flight tested on a small personal airplane, the Fairchild F22, was judged to be acceptable and to need no further development. But even if designers accept the greater mechanical complexity of the split flap, there are drawbacks to the use of this device. The narrowness of the chord has to be compensated by greater deflections, high gearing ratio of ailerons to control stick and probably high stick forces. Besides, the maximum rolling moment that can be obtained with an aileron set at any angle decreases with the aileron chord. The aileron is limited to the area aft of the flap. Accordingly the effectiveness of such a control is limited.

A2 — Auxiliary Surface Ailerons

(Ref. 7). The auxiliary surface aileron of Fig. 2 deserves only the briefest mention. It was intended to be a lift increase device as well as a control. The operating mechanism was so arranged that only one auxiliary airfoil rotated its trailing edge when the control stick was moved, while the other auxiliary remained stationary. The pilot found it nearly impossible to move the control stick from neutral. The stick forces might have been reduced by relocating the hinge axis, but the control was soon abandoned.

A3 — External Ailerons

(Ref. 7). The external aileron shown in Fig. 3 deserves no greater consideration. Down movement gave too much lag. Up

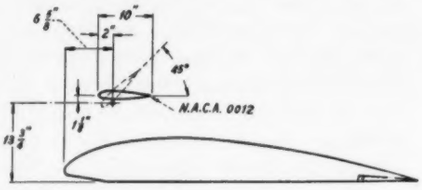


Fig. 3 : External ailerons.

movement showed no lag, but rolling moment was weak and practically constant at all speeds. Yawing moment was slightly favourable, but stick forces were far too heavy. The heavy stick forces and the air drag in supporting the hinge justified abandoning this device.

A4 — Upper Surface Ailerons

(Ref. 7). In this experiment the main flap was 20 per cent of the wing chord and so was the upper surface aileron of Fig. 4. The pilot

Fig. 4 : Upper surface aileron.

reported that the rolling action was fairly satisfactory, flaps up or down, but did not approach the effectiveness of conventional ailerons. Stick forces were excessive. The yawing action was slightly adverse with flaps

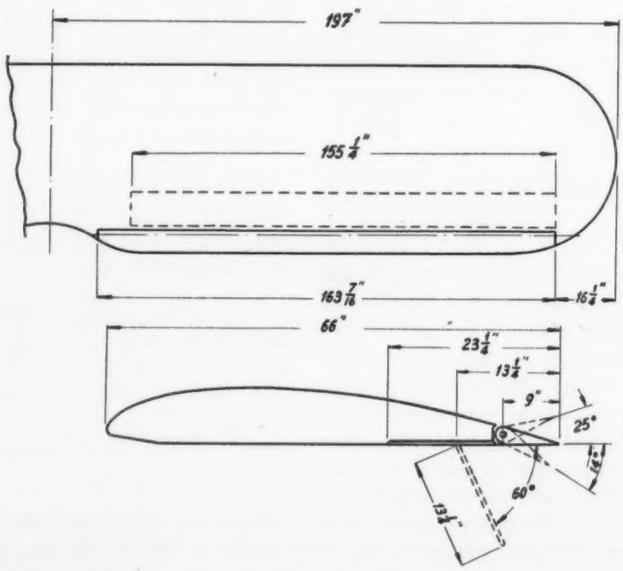


Fig. 1 : Split flap retracting forward of narrow conventional ailerons.

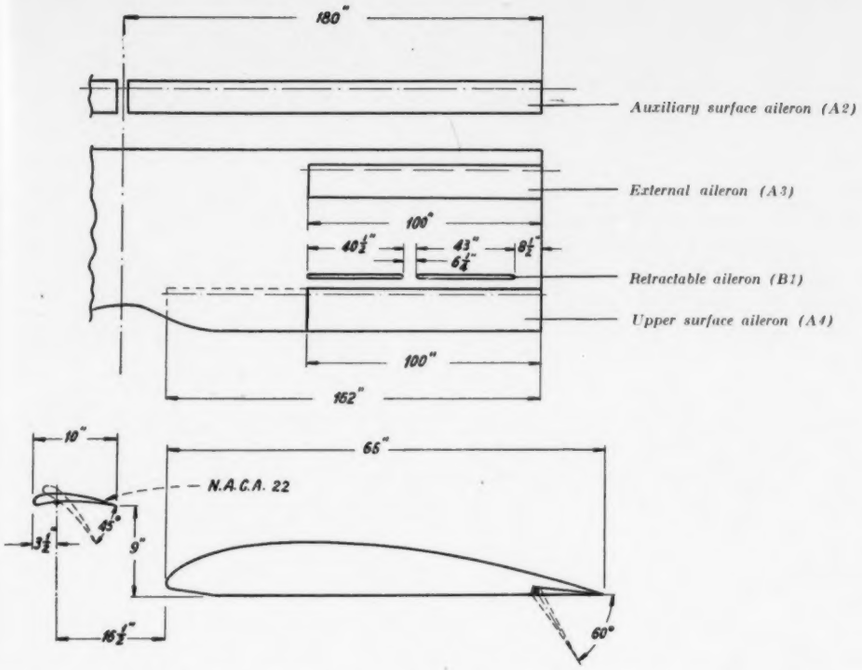


Fig. 2 : Auxiliary surface ailerons (A2). Plan (above) also shows A3, A4 and B1 arrangements.

up and definitely adverse with flaps down. It seems peculiar that raising the aileron should reduce the drag on that side of the wing, but evidently the induced drag is reduced by a greater amount than the profile drag is increased.

A5 — Hinged Flap Spoilers

(References 8 and 9.) It is generally recognised that the spoiler is particularly well adapted to use with full-span flaps. The

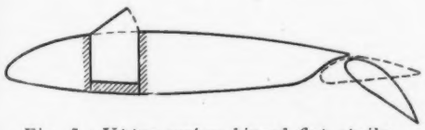


Fig. 5 : Upper surface hinged flap spoiler.

upper surface hinged flap of Fig. 5 is one of the earliest of the spoiler-type controls. It has shown similar results with split flaps and plain slotted flaps. The aerodynamic action of these spoilers can be defined in few words : they break the flow over the upper surface of the wing, prevent its return to the surface, and decrease its lift. They increase in effectiveness with the lift coefficient of the wing with flap either neutral or deflected, yawing moments are usually " favourable. " Their effectiveness is about the same as the effectiveness of other spoilers. But these hinged flap spoilers show two objectionable characteristics common to most spoiler-type controls : they are ineffective at small spoiler projections (the flow returns to the surface of the wing before the trailing edge), and there is a noticeable lag between the operation of the device and the response in roll. These drawbacks are reduced or disappear as the spoilers are shifted further back to the trailing edge, and it is conceivable that the hinged flap upper surface spoiler could give sufficient control for some types of airplanes. They have another objectionable feature which is not easy to overcome : the excessive hinge moment which could be expected from their configuration.

A6 — Flap Type Deflectors

(Ref. 8.) Flap-type deflectors can be either forwardly hinged as shown in Fig. 6, or rearwardly hinged. They have an action

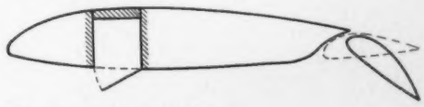


Fig. 6 : Flap-type deflector.

which is opposite to that of a flap or other type spoiler working on the upper surface of the wing, since they work in a region of favourable pressure gradient, and the airflow returns to the wing surface behind the wing. The deflectors have small lag and are effective at small projections. They give large hinge moments and maximum rolling moments that are not too powerful. But the strongest argument against the flap-type deflectors on the lower surface of the wing is the irregularity of their behaviour when referred to angle of attack. At low value of C_l they actually increase lift. At higher C_l, with main flap depressed, they decrease lift, and the rolling moment changes sign accordingly. Such irregularity in rolling moment action cannot be accepted.

A7 — Spoiler-Deflector-Slot Combinations

(Ref. 8.) Tests have been made of spoiler-deflector combinations, whose characteristics are roughly the summation or weighted

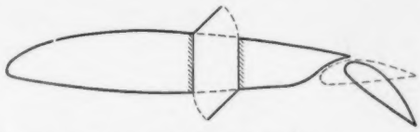


Fig. 7 : Spoiler-deflector-slot combination.

average of their components. The addition of the slot, shown in Fig. 7, improved the rolling moment and lag characteristics, and did not introduce drag since the slot is closed with the control neutral. The hinge moments remained unacceptable. Another reason for not employing the spoiler-deflector-slot combination is the structural complexity due to the slot through the wing.

General Conclusion for Group A

The conclusion is inescapable : in spite of the time and effort spent on the various devices of Group A, and in spite of the fact that they would permit a full-span flap to be installed, none of them are acceptable. Negative information of this sort is valuable to the designer since it tells him in what direction effort will be wasted.

B. A GROUP OF MORE MODERN LATERAL CONTROLS

Group A of early lateral control devices proved disappointing ; Group B has shown the way to complete solution of the problem.

1B — Retractable Ailerons

(Ref. 8.) It was when the upper surface ailerons (which we have classified as A4) were found to have intolerable hinge mo-

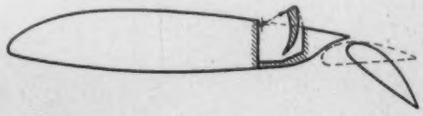


Fig. 8 : Early type of retractable ailerons.

ments, that investigators turned to the retractable aileron of the type shown in Fig. 8. This type of aileron, it will be noted, is wider at the top of its curve, and in general has solidity or thickness. These ailerons had much lower hinge moments than the upper surface ailerons, and were quite effective in rolling moment. The rolling moments increased with lift coefficients as they should.

They suffered from lag, but the lag was tolerable when the retractable aileron was placed far enough back on the surface of the wing. The yawing moments were either favourable or, if adverse, they were small. This first type of retractable ailerons certainly constituted a step forward. But they also have some real drawbacks: the rolling moment only comes into play after the wing projects 0.02 *c* above the wing surface (at low projections the airflow returns to the upper surface of the wing), and such a characteristic can lead the pilot to over-control. Because of the suction on the upper surface of the wing, the aileron tries to pull out from neutral, so that hinge moments are negative at small projections, and become positive only at fairly large projections. Such hinge moments lead to an irregularity of stick feel that a pilot would object to.

Some Typical Test Results. Plate I

We have thus far spoken of the results obtained in qualitative terms. Plate I shows the actual curves for the B2, an early type of retractable aileron. We shall discuss these curves *pour fixer les idées*. The lag values in the top righthand corner are taken from a film in which the rolling moments were photographed against electrically-recorded deflection positions, and comparisons made with the moments obtained under static conditions for the same given control deflection. Lag values are somewhat above the 1/10 second which is generally taken as permissible. The rolling moment curves show, not lag, but the undesirable characteristic so often noted with spoilers that not until the projection is 0.02 *c* or even more, is a rolling moment developed. Because of this undesirable characteristic, the rolling moment coefficients are far from being linear when plotted against aileron projections. On the other hand the maximum values of C_l are high, and with flap deflected are higher than with flap neutral, which is as it should be. Yawing moments are not too high and "favourable," the signs of both rolling moment and yawing being positive. Only with flap deflected and at large aileron projection, do the yawing moments become negative. Under this condition, the reduction in "induced drag" is evidently greater than the increase in "profile drag." The curves as a group give an excellent idea of the problems presented by spoilers.

B2 — Curved Plate Retractable Ailerons

(Ref. 10.) At no point in this lengthy investigation was there any *coup de foudre* or great inspiration. The investigators advanced slowly, learning from each experiment. The curved plate retractable ailerons of Fig. 9, placed so far back as to be very near the slot of the main flap, avoided some of the drawbacks of the type previously described and classified as B1. There was now little lag. A rolling moment was developed no matter how small the aileron projection. With flap down and fairly large

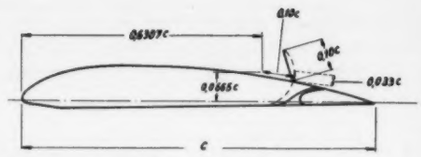


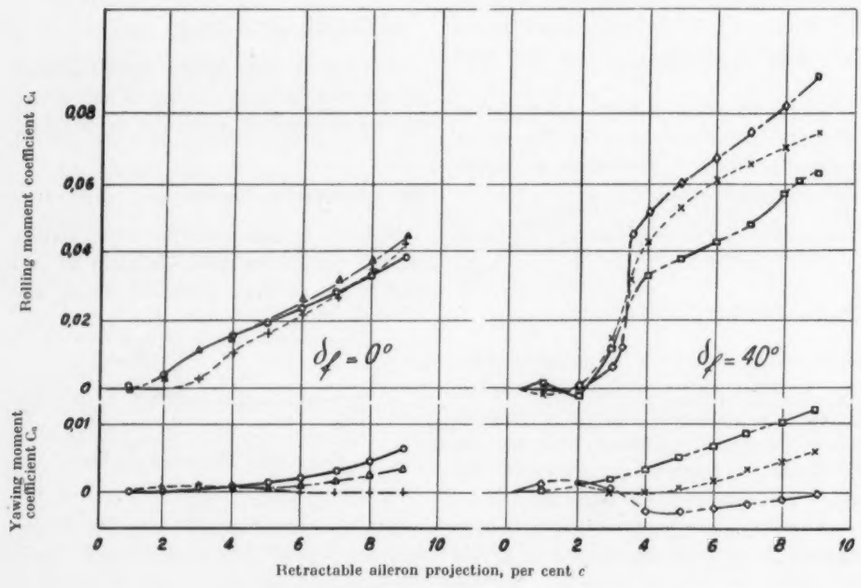
Fig. 9 : Curved plate retractable aileron.

aileron chord, C_l was almost linear when plotted against aileron projection. Yet the curved plate retractable aileron is not completely satisfactory because of two things: with flap retracted, yawing moments are favourable, with flap down they are definitely adverse. Such variation would be disconcerting to the pilot. The hinge moments were not measured, because this type of aileron has no aerodynamic hinge moment when the hinge is located at the centre of curvature of the aileron. It was suggested that a better "feel" for the control could be obtained by placing the hinge axis slightly below the centre of the aileron radius.

Flight tests of a curved plate retractable aileron are reported in Ref. 11 and in general confirm the wind tunnel tests. Flap depression increased effectiveness: the pilot did not notice lag, and reported favourable yawing moments only. Perhaps the range of tests did not go far enough for the adverse yawing moments of the wind tunnel tests to be encountered. The hinge moment of the ailerons was too light to provide any feel.

A variant of the retractable aileron is a curved plate of less range than its range of travel, so that a gap is left between the wing and the lower edge of the aileron. When the gap becomes large, discontinuity occurs in the yawing and rolling moment coefficients if plotted against angle of attack. The curved plate aileron of less chord is less powerful than the aileron in which no gap is formed.

(To be concluded next month.)



	Flap deflection δ_f	Rolling moment c_l	Lag. Sec. sec
○	0	0,41	0,14
△	0	0,94	0,12
+	0	1,46	—
□	40°	1,08	0,12
×	40°	1,73	0,14
◇	40°	2,40	0,18

Plate I : Test results for early type (B2) of retractable ailerons.

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"SPEEDPAK"

A Lockheed "Constellation" in flight with a "Speedpak."

If we look back upon the development trends in civil aircraft construction of the last ten years, we cannot help gaining the impression that altogether too much attention has been devoted to long-range airliners. As a result, we are not short of modern trans-Atlantic aircraft, but we are still more or less dependent on the old and proven Douglas DC-3 for short and medium hauls. Besides, the newest short and medium-range transports, apart from a few European prototypes, are fitted to seat about forty passengers.

The policy may be alright as regards trunk lines and links between cities. But for less patronised routes, or services used irregularly, it often happens that these new types can only break even provided the lack of passengers can be compensated with cargo.

An analogous set of problems today confronts the airline companies desiring to operate their long-range equipment over medium routes. In the interest of good flying qualities, the fuselage dimensions of heavy aircraft are limited to a minimum, so that an economic exploita-

Loading a "Speedpak" with luggage and freight. Easy ground loading reduces expensive waiting time for "Constellations" at airports. A small tractor lies ready to tug the pre-loaded "Speedpak" to beneath the plane.

tion of the cabin space for cargo carriage is very seldom possible. Should it therefore occur that one of these airliners is only partly occupied by passengers, the limit is very quickly reached where the volume capacity prevents full utilisation of the load capacity.

For a time it looked as though aviation would follow the example of road haulage contractors. Certain optimists described in great detail mythical "air trailers," which involved a powered aircraft tugging a row of cargo gliders that could be released or picked up at any desired point of the journey. The successes of military air transport fleets in the transportation of troops and equipment by means of aeroplanes and gliders seemed to indicate the way for civil aviation.

Luckily, however, airline operators are seldom dreamers. They left the idea of scheduled transportation by air trailers to journalists and went to work with the aircraft engineers to examine the possibilities of improving on modern airliners.

Astonishing requirements were set and fulfilled during the war. There is scarcely an aircraft which, during its military operation, did not meet demands that had been pronounced impossible after careful calculation by its constructors. As the war theatres expanded, great excesses in gross weight and disposable load became an understood thing ; and additional loads of fuel or bombs were simply attached to the wings or fuselage if there was not sufficient interior space.

The engineers of *Lockheed Aircraft Corporation* were guided by the same thought when customers asked them how the volume capacity of the "*Constellation*" could be augmented for use on short and medium hauls. In answering the question, they simultaneously endeavoured to remove a further worry for the airline operator and designed the "Speedpak," an outboard container which requires no modification of the aircraft and can be attached quickly at any time. Providing 395 cu.ft. of space, the container weighs 1,700 lbs. empty and can take on several times this amount in cargo. Designed to fit snugly against the fuselage and equipped with electric motors for hoisting, the boat-shaped "Speedpak" is 33 ft. long, 7 ft. wide and 3 ft. deep.

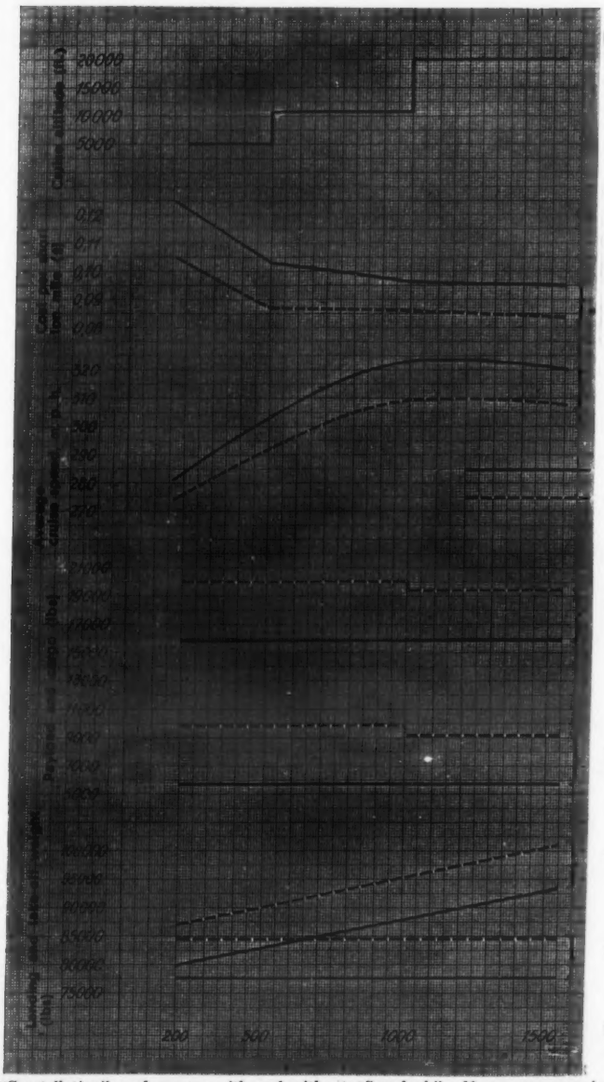
Whereas the contact edge of the "Speedpak" is rubber-padded, a waterproof tarpaulin gives additional protection for the baggage compartment.

In order to save time, freight and luggage can be pre-loaded into separate light-alloy containers and later slipped into the "Speedpak." Once loaded up, the "Speedpak" is rolled along on four small, built-in wheels and attached beneath the fuselage without hindering the passenger traffic.

The increase in payload due to the "Speedpak" entails only a small decrease in the "Constellation's" cruising speed, in fact 10 m. p. h. The tables and curves below show the inflence of the "Speedpak" on weight distribution, flight characteristics and direct operating costs of the "Constellation" for ranges of 200, 500, 1,000 and 1,500 miles.

Rolled along on four small wheels, the "Speedpak" is hoisted by built-in electric motors. The entire operation requires no more than two minutes.

Thanks to a side flap-door, separate items of luggage can be unloaded without having to detach the "Speedpak" during short stops.



"Constellation" performance with and without "Speedpak"; 60-passenger version; four Wright "Cyclone" twin-row radials at max. cruise; fuel reserve for 200 miles plus 45 min. on weak mixture; airfield at sea level; no head-wind.

Range, 200 miles.

	Without Speedpak	With Speedpak
Take-off weight	80,212 lbs.	87,200 lbs.
Landing weight	77,712 lbs.	84,500 lbs.
Payload	15,840 lbs.	20,000 lbs.
Cargo and baggage	5,640 lbs.	9,800 lbs.
Average cruise speed	284 m.p.h.	276 m.p.h.
Direct operating cost per ton mile	$ 0.122	$ 0.103
Cruise altitude	5,000 ft.	5,000 ft.

Range, 500 miles.

	Without Speedpak	With Speedpak
Take-off weight	83,062 lbs.	90,365 lbs.
Landing weight	77,712 lbs.	84,500 lbs.
Payload	15,840 lbs.	20,000 lbs.
Cargo and baggage	5,640 lbs.	9,800 lbs.
Average cruise speed	303 m.p.h.	292 m.p.h.
Direct operating cost per ton mile	$ 0.103	$ 0.087
Cruise altitude	11,500 ft.	11,500 ft.

Range, 1,000 miles.

	Without Speedpak	With Speedpak
Take-off weight	87,729 lbs.	94,800 lbs.
Landing weight	77,712 lbs.	84,500 lbs.
Payload	15,840 lbs.	19,360 lbs.
Cargo and baggage	5,640 lbs.	9,160 lbs.
Average cruise speed	323 m.p.h.	309 m.p.h.
Direct operating cost per ton mile	$ 0.096	$ 0.086
Cruise altitude	20,000 ft.	20,000 ft.

Range, 1,500 miles.

	Without Speedpak	With Speedpak
Take-off weight	92,500 lbs.	100,480 lbs.
Landing weight	77,712 lbs.	84,500 lbs.
Payload	15,840 lbs.	20,000 lbs.
Cargo and baggage	5,640 lbs.	9,160 lbs.
Average cruise speed	321 m.p.h.	308 m.p.h.
Direct operating cost per ton mile	$ 0.095	$ 0.084
Cruise altitude	20,000 ft	20,000 ft

For the present, two carriers plan operating "Constellations" in Europe: *Aer Lingus Teoranta*, the Irish airline, and *K L M Royal Dutch Airlines*. In order to make full use of the flight characteristics of the "Constellation" designed for trans-Atlantic operations, both these companies will have to use the "Speedpak" on their European routes. This device offers indisputable advantages for distances between 300 and 1,500 miles, and the slight penalty in cruising speed is hardly noticeable, especially on short routes. Moreover, any means of saving time at terminals is bound to appeal both to passengers and airline operators. *Bi.*

The Air Hostess Told Us...

Blue Ribands...

Eastern Air Lines reports that, as a result of a new record schedule put into operation in June, it is now possible to have breakfast at a normal hour in New York, lunch in Miami, 1,100 miles away, and dinner at the usual time back in New York. Who wants breakfast in New York, lunch in Miami and dinner again in New York, anyway ? Esmeralda says that she, for one, would stay in Miami.

Our favourite air hostess is quite genuinely concerned about the record craze that seems to have broken out again. Not, she says, because of the fact that pretty Diana Cyrus, of California, wants to break Reynolds' round-the-world record or that Reynolds himself proposes to rush around the globe again, this time flying the hard way, via the North and South Poles.

Esmeralda thinks the airline's themselves have caught the Blue Riband fever. On June 2nd, EAL established that record between New York, Miami and New York ... on May 18th, the company made another record on the Burbank (Calif.)—Miami route ... on April 20th, PAA flew from Gander to Shannon in record time ... on the same date Scandinavian Airlines did the same thing between New York and Oslo .... on April 25th, BOAC broke PAA's Gander—Shannon record by 27 minutes ... the following day this record was again improved upon by 5 minutes and PAA ... on April 28th, Air France established a record between Gander and Paris ... on April 27th, the Irish Aer Lingus got a move on and flew from Dublin to Northolt in record time ... on ... and so on. The one redeeming feature of record flights seems to be that it will no doubt amuse undesirable relatives or friends of passengers to know that the passengers are the ones to stooge around the airport waiting for them to arrive, instead of vice versa, as is usually the case.

At this record rate, however, the day is not far when airliners will fly so fast that they land in Europe two hours before taking off from New York.

... and Red Ink

Esmeralda wonders if these flights were flown at "most economical cruising speeds" and helped along by terrific tail winds alone. If temptation got the better of the pilots and they opened their throttles a little more than they should, there is little wonder that most of the airline companies are using red ink for their book-keeping. Mr. Per A. Norlin, Director of the Swedish SILA, stated not long ago that the Scandinavian Airlines System, of which SILA is a member, is operating its Douglas DC-4 aircraft on the Atlantic at a loss. This loss would still be heavier, he informed the Associated Press representative at Seattle, Wash., home of the Boeing Aircraft Co., when the new, much larger and faster Boeing "Stratocruisers" go into operation.

Our favourite hostess confesses she does not quite know what to think. It seems to her that an airline operating the fastest and hugest equipment has no chance of survival. Since its aircraft are so fast, they may eventually land before taking off, and because they are so gigantic, the line will be broke after one trip, i. e., in this case, before they have flown at all. If this continues, Esmeralda says, she will end up as a pedestrian.

Apparently the Scandinavian Airlines System agrees that there is something wrong somewhere. It suggested recently that the airlines shouldn't fuss so much over every "fastest flight," but that a Blue Riband should be awarded to the company which adheres to its operating schedule most closely over a given period of time. The International Air Traffic Association in Montreal is showing interest in the proposal, and Esmeralda ventures the observation that one day, maybe, a passenger may know in advance when his flight will leave New York and arrive in Europe.

Stars in the skies ...

A recent debate in the House of Commons recalled that in some of the British transport types passengers sit facing each other, as in European railway trains. In the latest models, British passengers will now all sit facing forward—much to the satisfaction of Lieut-Colonel Sir Walter Smiles, M. P. The Colonel opined, in effect, that on a flight from England to Australia, anybody would get tired of staring into the face of someone else sitting opposite. "Even if Ingrid Bergman and Greta Garbo" (the Colonel seems to have a weakness for Northern beauties), "the two best-looking women in the world, were compelled to look at each other all the way to Australia, I think each would tire of the other's face ..."

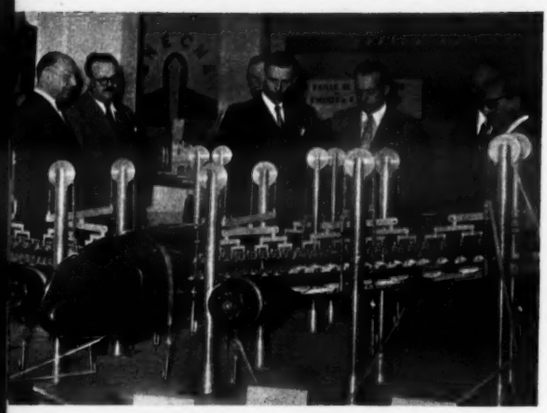
Our favourite hostess objects. Put any man under ninety into Greta Garbo's seat, she says, and watch. He certainly wouldn't only stare at Ingrid Bergman's face, and he wouldn't get tired of what he saw.

Incidentally, this Parliamentary debate took place shortly before various reports were received from Britain and America, claiming that, surprisingly, a majority of male passengers prefer to sit facing the rear of the aircraft. Since in most present-day airliners the entrance is at the back, Esmeralda suspects that, if the new arrangement were ever adopted, each traveller would watch the door in the hope to see Greta Garbo or Ingrid Bergman strolling up the aisle and languidly dropping into the seat in front of his nose. Our favourite hostess thinks that the men passengers would even be fascinated by staring at the top of their hats.

P. A. B.

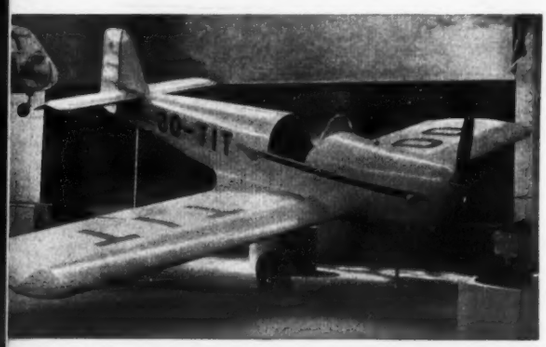
The IIIrd. International Aircraft Exhibition in Brussels

July 4th - 20th, 1947



Official opening : the *Belgian Minister of Communications, Achille Van Acker* (second from left), and the *Minister of Defence, Colonel de Fraiteur* (third from left), viewing the French ONERA stand.

Model of the Belgian *Florine 4 experimental helicopter*, developed at the Ministry of Communication's research centre.



Tipsy "Junior," single-seater for assembly at home ; air-cooled engine of 25 to 65 H. P.

Two-seater *S 91*, built by the French SIPA (Société Industrielle pour l'Aéronautique) concern ; 85-H. P. Continental engine and Aeromatic propeller.

Brussels, July 7th. — Did you ever have a chance of visiting an aircraft exhibition building on the eve of the show's inauguration ? It is a tradition that the entire hall should give an impression of hopeless confusion, and it usually seems to be altogether excluded that the organisors and exhibitors will ever complete their jobs in time. But the miracle invariably occurs : five minutes before the ceremonial opening of the show, workers carrying ladders and pots of paint make their retreat through the rear exit and the reflections of high-ranking personalities become visible in the gleaming metal parts of the aircraft on exhibition.

The 1947 Brussels aircraft show did not completely uphold this tradition. The picture on the eve was as usual. But the painters, decorators and mechanics had not disappeared by the time the doors were opened, the aircraft had only partly been unpacked and assembled, and even the clever manoeuvring of the guards of honour and the military displays could not hide the fact that the organizors of Belgium's first postwar aircraft show had had to contend with almost insuperable difficulties. No sooner had the visitor had time to overcome his disappointment at the absence of the Society of British Aircraft Constructors, than he had to digest the news that further foreign exhibitors, notably Fiat, had made last-minute decisions not to participate. The gaps which ensued were such that every effort of the Belgian military and commercial aviation authorities could not conceal them.

The list of exhibitors is short. Apart from the *French export organisation, OFEMA,* whose members are all exhibiting together, though, with the exception of Société Industrielle pour l'Aéronautique (SIPA), limiting their exhibits to models and photos of their products ; and apart from the union of accessory manufacturers (Chambre Syndicale des Accessoires) and the State research institute, ONERA (Office National d'Etudes et de Recherches Aéronautiques), it is indisputably the *Czech aircraft industry* which has contributed most towards the international character of the salon. In addition to the *Walter* and *Zlin* engines, which were on show last year at the Paris Salon, the Czechs are exhibiting the *Praga E. 211* twin-engined four-seater personal aircraft (pusher airscrew development of the Praga E. 210). Weighing 2,190 lbs. empty and capable of carrying a payload of 995 lbs. at a maximum all-up weight of 3,175 lbs., the E. 211 features a lavish array of instruments for a personal plane, though the seating space is a little restricted, particularly in front. Two Walter Minor 4-III air-cooled in-lines drive fixed wooden airscrews ; cruising speed is quoted at 125 m.p.h. The *Zlin 22* two-seater private plane built by the national Otrokovice automobile corporation, which was only visible in model form at the Paris Salon, is on full show in Brussels. The clean finish and arrangement of the cockpit and instrument panel make an extremely good impression, even when compared with the much more expensive American types. A novelty which is highly interesting from the technical angle, but which may require some time before it has been perfected, is the *Praga E. 1* rotary-wing project, a two-bladed rotor helicopter. The power plant, transmission mechanism and rotor hubs are built to form a unit sub-assembly which swivels about a horizontal axis. The engine casing is flanged to the rotors' gear-box and two cylinders project in staggered formation from either side of the casing. The inclination of the rotor discs is controlled by an oleo-pneumatic valve located on the left side of the cockpit ; pitch variation is accomplished by adjusting the control stick. Powered with

100 H.P., the Praga E. 1 is expected to attain 87 m.p.h. in horizontal flight.

The *U. S. aircraft industry* has been content to have its Belgian agents exhibit the well-known Cessna, Piper "Cub," "Ercoupe," and North American "Navion" personal planes. The Danes are represented by Skandinavisk Aero Industri A/S, who have the KZ VII "Lark" four-seater tourer on show. As regards the *British* contributions, *Cunliffe Owen* has a model of the new "Concordia" commercial transport at the exhibition, and *Dunlop* is showing new developments in the way of undercarriages and armament. The most decorative stand in Brussels is probably that of the *Goodyear* rubber firm, of the U. S. A. *E. Marelli,* who is exhibiting electrical equipment for aircraft, is the only Italian concern represented in Brussels.

The *SIPA S 91,* a new French personal plane powered with an 85-H.P. Continental engine driving an Aeromatic propeller, is for export. It is equipped with a conventional fixed undercarriage and features the following characteristics and performance figures : span, 28.7 ft. ; length, 18.9 ft. ; height, 5.74 ft. ; wing area, 124 sq. ft. ; empty weight, 830 lbs. ; disposable load, 570 lbs. ; gross weight, 1,400 lbs. ; maximum speed, 127 m.p.h. ; landing speed, 43.5 m.p.h. ; ceiling, 18,700 ft. ; take-off run, 426 ft. ; range, 500 miles.

The French nationalised Aérocentre concern is exhibiting a new two-seater personal plane, the *NC 850* "*Club,*" which is of the same performance category as the above type. Fitted with a 75-H.P. Mathis engine and weighing 1,365 lbs. gross (845 lbs. empty), it possesses a top speed of 105 m.p.h. and a range of 310 miles.

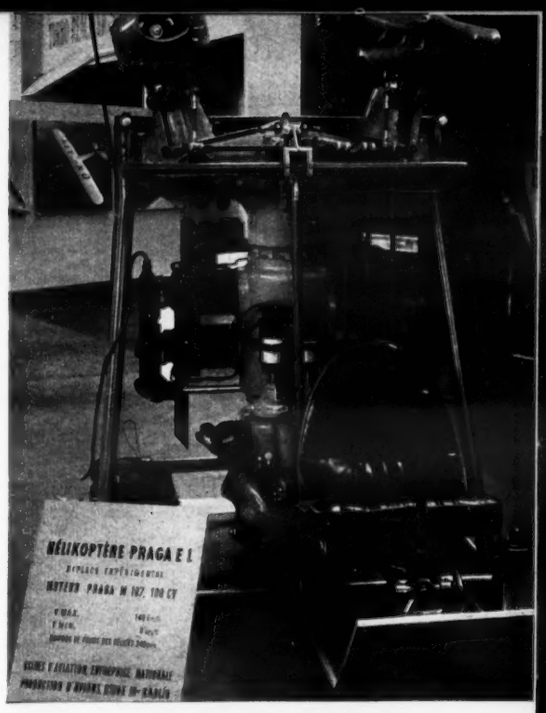
Finally, we come to the Belgian exhibitors. The homeland's contribution is definitely domineered by the airline side. *Sabena,* the national airline company, proves with a number of imposing maps that it is well in the first rank of European operators. Moreover, there are a good number of Belgian charter companies, large and small ; the most important of these is Sobelair (Société Belge des Transports par Air, S. A.), which has five "Dakotas" and specialises in charter services to North and Central Africa.

Besides his well-known two-seater, the Belgian constructor, Oscar Tips, has a new single-seater plane on show. As this plane can be partly assembled at home and the constructor vouches for its reliability, it stands a good chance of capturing the enthusiasm of the young, airminded public. Called the *Tipsy* "*Junior,*" it is of wooden construction, can be fitted with almost any type of 25 to 65-H.P. engine, and is to be delivered in sections. The amateur also receives all the parts and fittings which are important from the strength point of view, so that he may expect an airworthiness certificate for his construction. Meanwhile, however, the price of the airframe sections alone comes to about Belg. frs. 40,000 (about $ 1,000), so that a wide distribution of the Tipsy "Junior" does not seem to be in the cards just yet.

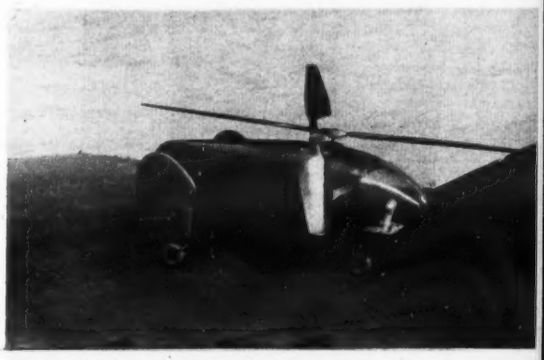
The main attraction of the Brussels show was the *flying display on July* 6th at Evere Airport, where commercial, personal and service aircraft were demonstrated for over three hours. Worthy of mention were the Sabena display of three Douglas DC-4's and six Douglas DC-3's in formation, the extremely brilliant show of aerobatics put on by an R. A. F. section of three de Havilland D. H. "Vampires," and the impressive demonstration of the British Vickers-Armstrongs "Attacker" jet fighter.

The writer could not permit himself to stay on in Brussels until all the exhibitors had arrived. He left Belgium on the fourth day of the show, just when the finishing touches were being given to the placards along the roads leading to the Halle du Cinquantenaire, inviting visitors to come to the exhibition. It is to be hoped that the trouble taken by the organisors and the sacrifices borne by the exhibitors will be rewarded by a more numerous and less disinterested flock of visitors during the second half of the IIIrd. International Aircraft Exhibition in Brussels. And perhaps by then the catalogue will have been printed.

Bi.



Engine and transmission of the *Praga E. 1 helicopter* ; cooling blower, engine and rotor-gear casing built up to form a unit sub-assembly which can swivel about a horizontal axis.

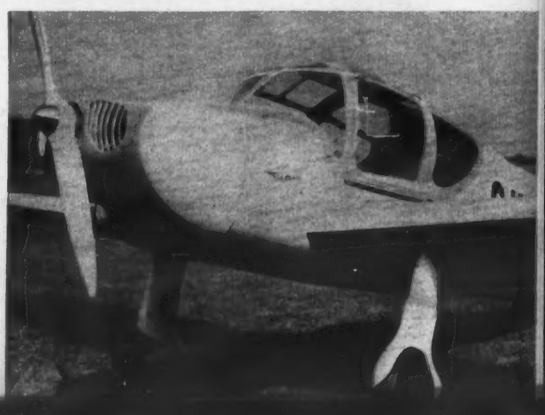


Model of the Czech *Praga E. 1 helicopter.*

Praga E. 211 four-seater tourer with two pusher airscrews, built by the Czech national aircraft corporation in Karlin.

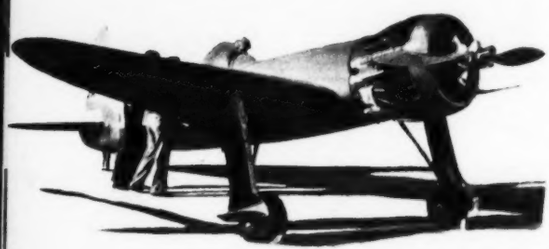
Czechoslovak *Zlin 22 two-seater* with 57-H. P. Zlin "Persy 3" engine.

KZ VII "Lark" four-seater personal plane, built by the Danish Skandinavisk Aero Industri A/S.



The Enigma from Houston

What will he do next ? How much did he inherit ? How much has he made ? Is he going to fly again ? Can he afford to sink more into that company ? Whom will he marry ? How many oilfields does he operate ? These and similar questions point to the enigma from Houston, Texas — Howard Robard Hughes.



The Hughes "Special" racer in which Howard Hughes set up several speed records.

Howard Hughes has four careers : aviation, motion pictures, oil drilling machinery, and aviation again. In each he has been a success. He builds aircraft, flys aircraft and owns a majority interest in a large airline. He has established half a dozen flying records. He has managed his father's business since he was eighteen and enlarged it enormously. He has produced some of the biggest hits on the silver screen. But in spite of his many activities, Howard Hughes, as a man, is practically unknown to his countrymen.

*

Howard Hughes was born at Houston, Texas, on December 24th, 1905, as the son of Howard R. Hughes, Sr., boss of the Hughes Tool Co., Houston, Texas, manufacturers of a special device for drilling deep oil wells through underlying rock. This device has never been sold to any of the oil companies, but rented to them, a much more profitable arrangement. Hughes Sr. had one hobby : to race around in fast cars, keeping a deposit of $ 1000 with the Houston police chief to cover his speeding tickets. Young Howard was a chip off the old block : whilst he had every opportunity for education, he let his attraction to high-speed racing and flying interfere with his academic life.

When he was fourteen, he had his first flights in an aeroplane ; at fifteen he raced his bicycle, fitted with a home-made motor, all over Houston ; three years later he started to take flying lessons.

He was eighteen when his father died, leaving him a sizeable fortune — which gossip soon claimed to have amounted to $ 17,000,000, $ 50,000,000, or even $ 75,000,000. But whilst Hughes certainly was not a pauper, he is essentially a self-made man. Though his father's estate was worth more than a million, the main asset was a three-quarter share in the Hughes Tool Co., appraised by the U. S. Government for tax purposes at $ 650,000 at the time, which is in sharp contrast to the mythical figures the young Texan is generally credited with having received. His guardians informed him that he could not obtain control of the company before he was twenty-one. Hughes immediately left college, went to court and got custody of his estate. When he was twenty, he bought the remaining 25-percent interest from other members of the Hughes family and became sole owner of the company. He expanded it, and the company now supplies more than eighty percent of the rock-bits used in deep-well oil drilling throughout the world, yielding about $ 2,000,000 in net profits a year. At one time Hughes was offered an estimated $ 50,000,000 for his business by an oil syndicate, but turned the offer down.

Hughes was not content to stay in Houston, Tex., managing his factory. One day in 1925 he arrived in Hollywood, was promptly wined and dined by movie executives on the look-out for capital. He listened to their talk, smiled and played hard-to-get, and went into independent production. The beginning was disastrous, but his third film, "Two Arabian Knights," won the Academy Award. In the succeeding eight years he produced numerous famous pictures, including "Hell's Angels," which netted him millions. In 1934, he wisely dropped the movie industry because of the depression and only decided to come back a few years ago with "The Outlaw," a much-disputed, though mediocre, film starring Jane Russell, which again is making big money.

Howard Hughes arrives in New York after his trans-Continental record flight of 1937.

*

His successful work in industry and motion pictures has enabled Howard Hughes to devote much time and money to his main interest, aviation. Since 1934 he has taken an active part in aeronautics. In that year he formed the Hughes Aircraft Company, near Los Angeles, and the following year his first product, the Hughes "Special" racer, was wheeled out from a shed at Glendale, where it had been built to the

The Lockheed 14, in a special version of which Hughes flew around the world in 1938.

Hughes (centre) returns from his round-the-world record flight.

designs of Richard Palmer, now special assistant to the President of Fairchild Engine & Airplane Corp. On September 12th, 1935, Hughes established an international speed record over 3 kilometres at more than 563 km/hr. (352 m.p.h.). He flew the same aircraft on January 19th, 1937, from Los Angeles to New York, to establish a new trans-Continental record of 7 hours 28 minutes. The U. S. Army was particularly interested in the Hughes aircraft and took it over for substratosphere flying trials. In 1938, the machine was finally sold to the Timm Aircraft Co. of Glendale, Cal., who proposed to derive a fighter from it, a project which never matured. — The Hughes Aircraft Company continued to exist, though inactive, until it was revived at Culver City, Calif., in January, 1941.

Howard Hughes had been an admirer of the one-eyed Wiley Post's pluck and skill in flying around the globe in 1933. In the autumn of 1937 he began careful preparations for his own round-the-world flight. From the Lockheed Aircraft Corp. he ordered a special version of the Lockheed 14 twin-engined transport, selected a crack crew comprising a co-pilot, navigator, radio engineer and flight engineer. He installed unusually complete wireless equipment which enabled the aircraft to stay in constant touch with New York throughout the flight, with the exception of a few hours over Siberia. Hughes took off on July 10th, 1938, and was back in New York on the 14th, 91 hours and 14 minutes later. His record stood for nearly nine years and was broken only last April. The flight was an achievement chiefly because it showed that fast, scheduled flying—the aircraft was never more than a few minutes late at the intermediary stops and never more than six miles off course, despite all types of weather encountered—was possible by means of celestial navigation over long distances.

To do things himself has always been the credo of Howard Hughes, as these record flights show. He prepares his projects and takes the risks that seem justified. More than once he narrowly escaped physical injury. The time he came closest to death was on July 7th, 1947. Hughes had made a habit of personally test-flying the aircraft he built. On that date he took off the XF-11 high-speed photo reconnaissance aircraft he had manufactured for the U. S. Army. A mechanical failure forced him to crash-land after a flight of some duration. His injuries were multiple : fractured skull, broken collar bone, broken nose, eight broken ribs, six punctures of the lungs, cuts and bruises. His physicians told him he was not likely to live. Two months later he flew a twin-engined bomber solo from Los Angeles to New York. On April 5 th, 1947, he piloted the second prototype of the XF-11 on its first flight.

Howard Hughes has also played a more indirect part in aeronautics. A close acquaintance of Robert Gross, President of Lockheed Aircraft, he is said to have been partly responsible for the design of the war-famous Lockheed P-38 " Lightning " twin-engined fighter. This claim may be true : the general lay-out of the P-38 and the Hughes XF-11 is basically similar. It is well-known that Hughes collaborated with Lockheed and Transcontinental & Western Air (TWA) in the conception and development of the Lockheed " Constellation, " one of the great airliners of today.

*

The way in which Hughes became connected with TWA is typical of the man. The founders of the company, Jack Frye and Paul Richter, at the time President and Vice-President, came to see him in 1938 to complain about pressure brought to bear on them by their financial backers. Hughes, an old friend of theirs, suggested that they should set up their own aircraft factory with his backing, or buy another airline. The upshot was that Hughes purchased a controlling interest in TWA.

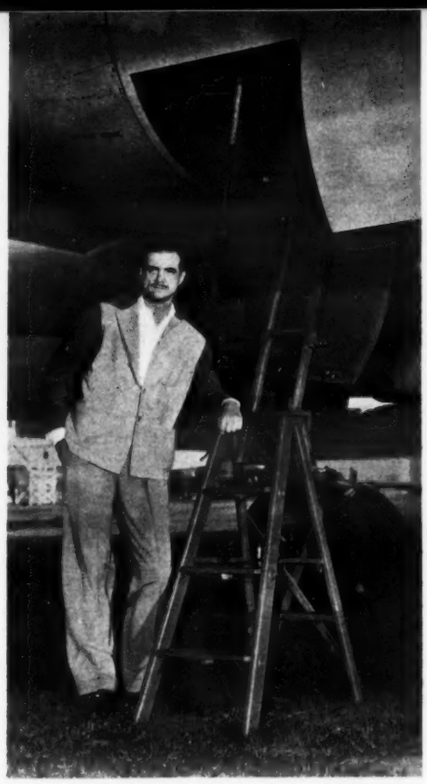
How long he will continue to control the airline, enormously expanded since the war, is an open question. After disagreements over policy, both Frye and Richter quit at the beginning of the year, and the entire management was changed last April. Due to its expansion, TWA is in need of considerable finance, and since January Howard Hughes has advanced it a total of $ 10,000,000. * But the company is still in a delicate situation : either Hughes finds additional outside capital to the tune of $ 40,000,000—which would dilute his holding—or he puts up the money himself. If he does neither, the company's future will largely depend upon the attitude of the Equitable Life Assurance Society, of New York, which in 1945 underwrote a ten-year loan to the company of $ 30,000,000.

*

Less than a year after Pearl Harbour, Hughes associated himself in another aviation project with Henry James Kaiser, wartime shipbuilding wizard. Together they elaborated the plans for a giant 200-ton, eight-engined flying-boat, originally designed as the first of a fleet of hundreds of cheap, quickly-built, all-wood cargo-carriers. This fleet was intended as an effective measure against the growing German submarine menace. The project proved anything but cheap. The Government-controlled Reconstruction Finance Corporation allocated $ 18,000,000 for the first three prototypes. However, Hughes and Kaiser soon ran into difficulties, and Kaiser resigned after a year. The RFC had to modify the contract, allocating the same sum for one boat only. Hughes, obstinate as ever, continued, sinking more than $ 2,000,000 of

* Cf. " TWA Grows Again, " May, 1947, issue, " INTERAVIA REVIEW. "

Hughes entering the ill-fated Hughes XF-11 on July 7th, 1946. He nearly lost his life in this aircraft later on the same day.



Howard Hughes, recovered from his accident and sporting a moustache, about to enter the second prototype of the XF-11 on April 5th to carry out successful flight tests.

On the way to hospital after his crash on July 7th, 1947.

The XF-11.

his own money into the construction of the aircraft. A year ago the flying-boat was moved from Culver City to a graving dock at Long Beach, Cal. It is expected to make its initial flight in the course of this summer. For Hughes, the boat is a labour of love : as with most of his aeronautical ventures, he cannot expect to make a profit on it. But the aircraft, the largest aeroplane ever built, is bound to teach valuable lessons concerning flying characteristics and construction methods of ultra-large aircraft.

*

Despite his achievements, Howard Hughes abhors personal publicity. Few of his habits are known. His "deaf ear" is famous : like many pilots of long experience, he is slightly hard of hearing—and uses the impediment to his advantage. His attitude towards money is sometimes bewildering : he can argue about the difference between 25 cents one minute, spend thousands of dollars the next.

Hughes has dark hair and brown eyes, is six feet three inches tall, lithe, loose-jointed. He is thorough, painstaking, cautious, but capable of scrapping a project in an advanced stage and starting all over again. Two episodes show this thoroughness : in order to become a proficient pilot on multi-engined equipment, he got a job, incognito, as an airline pilot and made himself a reputation as being brilliant, conscientious and steady ; he was fired when the company learned his true identity. Again, in order to familiarise himself with flying-boats prior to taking up the giant he was building, he bought one of the old Sikorsky S-43 twin-engined amphibians two years ago, one of the most delicately-handling flying-boats. In the succeeding months he made over 6,000 take-offs and landings with the boat and finally presented the C. A. A. with a motion-picture on flying-boat landing technique.

At the controls of the second prototype of the XF-11.

He brings to his work a high degree of engineering talent, creative ability and willingness to spend long hours on the job. His physical endurance is terrific. Habitually he shows up at factory or studio in the evening and works through the night. To outsiders he gives the impression of being quixotic, mercurial. When irritated, he is inclined to be scathing to his employees, and as suddenly turns on a mood of warm affability. He can be unpredictable in details : recently he took a dislike to the name "Hercules" for his flying-boat, also abolished the former numerical designations, HK-1 and H-4. He has ordered his associates to refer to the machine simply as the Hughes flying-boat.

He has the rich Californian's contempt for clothes, started on his round-the-world flight with a single pair of old grey trousers, an old tan hat and tan shoes. Socially he is pleasant, but reserved, quickly senses efforts to pry into his personal affairs. His spare time he spends at his Spanish-type house behind Wilshire County Club, near Los Angeles. How difficult it is to obtain details of his habits and background is disclosed by the fact a popular American national magazine spent years compiling a file on Howard Hughes and recently found that the whole contents had been stolen. In the past few months the U. S. press has become increasingly critical of Hughes, chiefly as a result of the long delays in the completion of the Government-financed flying-boat and his intransigent attitude during the T. W. A. reorganisation. To counteract this sentiment, he has now employed a firm of Los Angeles press agents, instructing his associates at the same time not to divulge any personal details to newspapermen.

Reputedly he likes the company of beautiful women, and over the years has been reported engaged to about thirty different movie queens and heiresses. He was married at twenty to Ella Rice, a Houston socialite, who divorced him four years later because he neglected her.

His abilities as a pilot are widely recognised. His flying is precise, smooth ; he handles his aircraft as if he loved them and loved to fly. "Interavia's" West Coast correspondent reported on a recent flight Hughes had made to demonstrate his new radar safety device to the press : "... Preceding the press showing of the gadget, he spent the entire day checking it and shooting landings with his 'Constellation.' Then he was host at a party and dance until he left at midnight. He was up at four, and then he was in his aircraft the better part of the morning and afternoon... He repeated his demonstration four times. All aboard were satisfied that his instrument worked, and that he himself is a *** good pilot."

*

Like many other things about Howard Hughes, his plans for the future are unknown. Certain is only that he will continue to operate the Hughes Tool Co., to make motion pictures, to brew beer at his Gulf Brewing Co., of Houston, and to operate his oil wells. These activities enable him to spend money

Hughes at the controls of a Lockheed "Constellation," ready to demonstrate his new Obstacle Warning Indicator (below windshield above throttle).

Hughes and Joe Petrali, Assistant Director of Service and Flight, beside the 200-ton Hughes flying-boat in its graving dock at Long Beach.

on aviation without hope of a return. At one time it appeared possible that the Hughes Aircraft Co. would go into the manufacture of transport aircraft. A feeder type got as far as the tentative design stage but was subsequently shelved. As a result, the Civil Aeronautics Board has no legal objection to his continuing as the majority stockholder of the big T.W.A. Occasionally he has taken on contracts for the conversion of war surplus aircraft for civil uses. He has also accepted a contract from the USAAF to conduct flight engineering trials with the German Messerschmitt Me 262 twin-jet fighter. During the, war, Hughes developed and manufactured flexible chutes for belted ammunition for use in combat aircraft, and similar accessories. At present, Hughes Aircraft's products include light rowing boats of laminated wood.

A certainty is, too, that Hughes will devote a major effort to the development of military and civil radar devices. A few weeks ago he made an important start in this sphere : from the War Surplus Administration he bought 2,000 APS-13 tail-warning radar sets, is now converting them into 15-lb. obstacle-warning indicators at the rate of 100 units a week. The equipment will be sold to commercial airliners at the cost price of $ 400 a set. Hughes is sounding out marketing possibilities and may decide to make the instrument from scratch.

Finally, the assumption is generally accepted that Howard Hughes's well-guarded factory at Culver City, Cal., is engaged on an important development programme for radar-controlled guided missiles and pilotless aircraft. The secrecy surrounding projects of this nature should suit Howard Hughes, on whom mystery seems to act like a tonic.

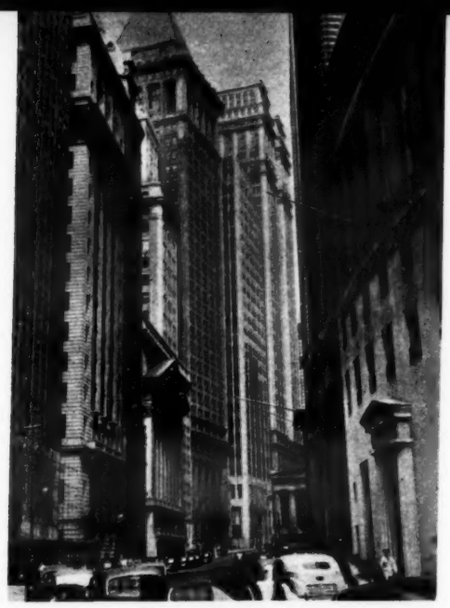
*

Private aeronautical research has never been a profitable business. That is the reason why aviation needs men like Howard Hughes, who make their money in other fields and spend it on aeronautics. His contribution to aviation, mainly the result of his personal, lonewolf efforts, has been great. And people who have managed to get a little closer to him than most others expect this contribution to continue. *P.A.B.*

The giant Hughes flying-boat, nearly completed, in its graving dock on Terminal Island, Long Beach.

Howard Hughes in the aft section of the flight deck of the giant flying-boat. Hughes and his assistant are wearing slipover shoes to avoid marring the deck surface.

Economic Aspects of the American Aviation Industry



(IV)*

The most unfavourable earnings for a number of years have been reported by the United States airline companies in the first quarter of 1947. For example United Air Lines, which has historically been a blue chip in the airlines group, reported a net loss, after provision for federal income tax carry backs, of $ 3,451,000, or after preferred stock dividend requirements, a loss of $ 1.85 a share on the common.

While more and larger airplanes were available to the company during the first quarter of this year than a year ago, pay load factors were sharply lower, which, coupled with unfavourable weather, resulted in a passenger load factor of 69 % as compared with 86 % in the first quarter of last year. However, at this date a favourable trend is noticeable in the monthly load factors, as March was by far the best of the three, amounting to 75 % as compared with 65 % in February and 67 % in January. Preliminary figures for April indicate that the load factor recovered to 83 %.

The following table shows combined operating figures for the airline industry for the three months ended March 31st.

United States (000 omitted)

	1947	1946	Change	%
Total Oper. Rev.	$ 75 113	$ 59 883	+ $ 15 230	+ 25.4
Net Oper. Income	d 20,669	d 3.960	— 16.709	— 422.
Revenue Plane Miles.....	73,333	63,908	+ 9.425	+ 14.7
Revenue Pass. Miles	1,289,381	1,067,663	+ 221.718	+ 20.8
Seat Miles	2,060,622	1,248,098	+ 812.524	+ 69.1
Load Factor	62.6 %	85 %		

d : Deficit.

In a recent C. A. B. decision United Air Lines was permitted non-stop operations between Los Angeles and Chicago, Los Angeles and Milwaukee, and points east of Chicago and Milwaukee. This decision forecasts approval of United's application to purchase from Western Air Lines its Denver-Los Angeles route for approximately $ 3,750,000. In this same decision American Airlines was given an entry into San Francisco ; and Transcontinental & Western Air, Inc., which already served San Francisco by an indirect route, was given direct entry from Chicago. All three transcontinental carriers now serve both Los Angeles and San Francisco. The decision also indicated that Western Air Lines, which was given an entry into Seattle, will now concentrate on regional traffic of a generally north-south character. In the opinion of students of the airlines the clarification of routes in the western part of the United States establishes United Air Lines in a dominant position in that region as United now serves almost every important city on the West Coast both with transcontinental east-west connections and with regional north-south connections. United Air Lines has been attempting for ten years to secure a direct connection between Los Angeles and eastern cities.

Leading transcontinental airlines are generally hopeful of profitable operations in May. From current indications both American and United almost broke even in April and expect to show reasonable profits in May. Transcontinental & Western should also succeed in getting into the black in May or June, and Pennsylvania-Central Airlines actually had a small operating profit in April, which, after other deductions, resulted in a modest loss. Eastern and National were the only two airlines in the black for the first three months of this year.

Prospects for the airline industry during the balance of this year still seem uncertain for many lines, but American Airlines is forecasting $ 95,000,000 of gross revenues for this year compared with under $ 70,000,000 last year and more favourable earnings in 1947 than in 1946, when a small loss was realised. On a similar basis United Air Lines should be able to secure $ 80 million of gross revenues this year against about $ 65 million in 1946 and about the same earnings as last year, when a moderate profit amounting to 54 cents a share was realised. On the basis of present estimates, monthly figures should be increasingly favourable this year as new equipment comes into service.

A number of the airlines are now receiving modern flight equipment which should have a favourable effect over the balance of this year on revenues and reported earnings. For example, both United and American are receiving deliveries of the DC-6's, now in service on both lines, and Eastern Air Lines is receiving delivery of the new gold-plated "Constellations." Using United Air Lines as an example, the potentially favourable effect of new equipment on revenues and earnings of the airlines is perhaps worth discussion.

At the end of 1946 United had 113 planes, consisting of 78 DC-3's, 26 DC-4's, 3 DC-6's and 6 Stinson trainers. On order were 32 additional DC-6's (not including the order for 5 which may be taken over from Western Air Lines), 50 Martin 3-0-3's and 7 Boeing " Stratocruisers. " The DC-6's were gradually being put into service, starting April 27th, and it is expected that 8 will be on regular scheduled runs by June 1st and all 35 by October. The Martin 3-0-3's are not expected to be available before March, 1948, and thereafter will replace Douglas DC-3's now in service, just as the DC-6's will gradually replace the DC-4's. It now seems likely that some of the seven Boeing " Stratocruisers " will be delivered in November of this year. This plane will be used for de luxe long-distance non-stop flights.

The DC-6 has been thoroughly tested and is more than living up to expectations. The plane is fast, cruising speed is 315 miles per hour, against about 220 to 240 m.p.h. for the DC-4, and carries 52 passengers against 44 passengers for the DC-4. The company is initially charging an extra fare of ½ cent a mile on DC-6 schedules, which will bolster gross revenues. Cargo capacity is 2,890 lbs. against from 3,800 to

* Cf. I (1946, No. 7), II (1947, No. 1), III (1947, N° 3).

4,090 lbs. for the DC-4, but experience has indicated that the DC-4's have extra freight capacity not being used in scheduled day-time flights and that the relationship between the passenger and cargo capacity of the DC-6 is more practical. It is expected that the DC-6's will carry as heavy freight loads as the DC-4's.

Assuming 9 ½ hours daily flight time for the DC-6, which is about normal, this plane should be able to account for from 2,800 to 3,000 revenue miles per day as compared with 2,000 to 2,100 for the DC-4 and against 1,900 revenue miles per day for United's fleet of 94 planes which was operating 178,000 miles daily last autumn. On the basis of these figures 35 DC-6's should be able to operate 100,000 miles daily, which would compare with 52,000 revenue miles daily for 26 DC-4's. Passenger revenue per mile for the DC-6 at capacity is $ 2.85, against $ 2.20 for the DC-4. The new fleet of DC-6's may, therefore, account for an increase in gross revenues of 2.2 times possible gross of the DC-4's, after adjusting for fare increases. It may of course turn out that certain DC-4's will be retained in operation even after receipt of all the DC-6's, if traffic holds up.

Direct flying costs, based on 1,800 mile flights, are 56.3 cents a mile for the DC-6 with full amortization in seven years and 58.5 cents on the DC-4 with two-year amortization. If the DC-4 expenses were computed with four-year amortization the direct flying costs would be about 10 cents less, or 48.5 cents per plane mile. In relation to capacity these figures are even more impressive. Direct flying costs per seat mile (excluding depreciation) are 1.4 cents for the DC-3, 1.1 cents for the DC-4, and 0.95 cents for the DC-6.

* * *

While over the last three months principal air transport securities acted about the same as the market as a whole, aircraft manufacturing equities were reactionary through most of this period. The principal shock to investors in the aircraft manufacturing group was the passing of the Glenn L. Martin dividend ($ 3 a share annually for several years) and the announcement that the company's financial position is restricted and that the company is applying for a $ 25 million loan for additional working capital from the Reconstruction Finance Corporation. As a result the stock broke sharply from a high of 34 earlier this year to a recent low of 14.

Other unpleasant news in the aircraft manufacturing industry also came to light. Republic Aviation reported a loss for last year of $ 4.47 a share and working capital declined from over $ 10 a share to under $ 5 a share. These troubles finally resulted in the resignation of Mr. Alfred Marchev, Chairman of the Board. Moreover, the problems of the light plane industry were highlighted by the decision of North American Aviation to stop production of the "Navion" executive type plane.

A further disturbing element, particularly to investors in Bell Aircraft Corporation, was the effort to secure control of this company by a group headed by Mr. Jackson Martindell, of Fiduciary Council, and Mr. Benjamin Graham, of Graham Newman. Mr. Edward Stettinius lent his name to the efforts of the group, but was not active in the proxy contest. Numerous allegations were made by both sides, but the issue involved seemed to be what disposition should be made of the very substantial working capital of the company. The stockholders voted by a considerable majority in favour of the present Bell management. In view of the relatively large working capital figures in relation to the current prices for a number of aircraft manufacturing shares there is no assurance that similar efforts will not be made by other groups in an effort to secure control of various other manufacturing concerns where working capital is substantial.

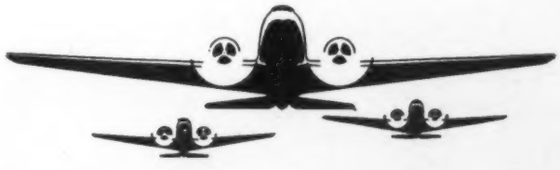
Little progress has been made in the Army-Navy Unification Bill and there seemed to be a disposition on the part of some members of Congress to let the merger die in committee. Also little or no clarification of the Government Aircraft Procurement Program has occurred in recent months. Final action on this matter may be delayed until further Congressional action on the budget recommendations has occurred.

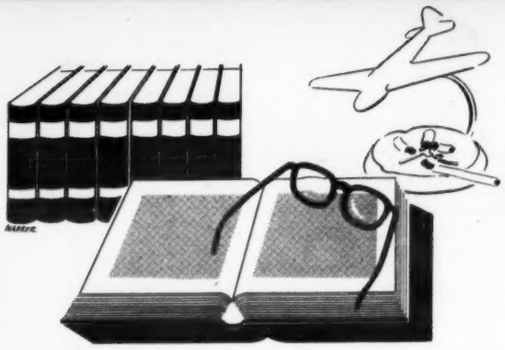
The following table shows various financial statistics and prices for aircraft manufacturing equities. The backlog of orders per share are based on information contained in the annual reports and downward adjustments may be necessary in some instances as a result of contract cancellations in recent months.

Company	Net C. A. per share 1946	Net Worth per share	1946 Earnings per share	Backlog per share	Price 28. 5. 47.	Range 1947
Beech	$ 17.76	$ 21.29	d$ 0.57	$ 84.08	6	12—6
Bell	26.05	43.10a	d 1.51	54.25	11 1/4	18 1/4—10 7/8
Boeing	39.13	42.83a	d 1.46b	194.44	15 1/4	23 1/8—14 1/8
Consol. Vultee	27.54	36.54	d 1.77	209.47	12 7/8	17 7/8—10 5/8
Douglas	88.37	123.45a	3.63	348.66	46 1/8	76—46
Grumman	45.25	48.95a	0.66	N.S.	17 1/2	27 5/8—17 1/2
Lockheed	33.13	38.09	d 9.98b	142.87	11 1/8	20—10 5/8
Martin	37.47c	50.73ac	2.97b	170.95	15 1/2	34—14
North American	10.65	11.98a	1.16	48.05	7 3/8	10 3/4—6 5/8
Republic	4.77	6.80a	d 4.47b	67.24e	4 5/8	9 7/8—4 3/8
United Aircraft	30.52	33.87a	1.79	107.26	18	21 1/8—16 7/8

Jeremy C. Jenks.
Baker, Weeks & Harden,
One Wall Street, New York, N. Y.

a Including contingency reserves.
b Before reserves.
c Including $ 20.18 per share of accumulated costs which were included in inventory.
d Deficit.
e Excluding Aircooled Motors' backlog.
N. S. No Statistics.





Book Review

Dive Bombing. By Erik A. Wilkenson. Published by AB Seelig & Co., Stockholm, 1947.

Between 1940 and 1943, whilst working as an engineer for the Saab Aircraft Company, Linköping, the author developed an aiming device for precision bombing during dives, which has since been adopted by the Swedish Air Force for all its fighters. With the permission of the Royal Swedish Air Force, Wilkenson has published the results of his theoretical examination of ballistic and aeronautical problems in this field, and his book is effectively a treatise for the Royal Swedish Institute of Technology in Stockholm.

The work is extremely extensive and, for the first time, deals thoroughly with all the problems of dive bombing and gives mechanically-utilisable solutions. For a long time to come, *Dive Bombing* will serve as a very valuable reference work for all theoretical problems in this particular field, and will also be appreciated in dealing with questions in ancillary fields. (English.)

Bi.

Manuel du Navigateur Aérien. By Lieutenant de Vaisseau Vaziaga. Published by Blondel La Rougery, Paris, 1947.

This manual, which completely reviews the basic problems of navigation, aerial photography, aeronautical meteorology and describes the aircraft instruments concerned, is the textbook of the French Ecole de l'Aéronautique Navale. In one lengthy chapter devoted to U. S. radio navigational methods, as in other chapters, the author merely lists the different systems, without going into detail. However, the section on meteorology is more complete, so that the book can be useful for practical use. All the same, it will sometimes be necessary to turn elsewhere for details. (French.)

Bi.

Le Transport Aérien. By A. de Castillon de Saint-Victor, Dunod, Paris, 1947

To give the history of aircraft construction, civil aviation and aviation economics in 235 pages, simultaneously reviewing the story of military aviation and dealing with the present and future development trends, is a big job, even if one knows us much about it all as the author, who is the technical director of the Comité Français de Propagande Aéronautique.

However, the book still forms a valuable contribution to the central debate of today. It fosters the idea that aviation must be a branch of transportation, the aircraft a means of transportation—nothing else ; and solemnly warns us to keep this idea in mind. Finally, we can agree with Louis Bréguet, who wrote the introduction, that the author's conclusions are entirely in line with the conceptions of all interested in aviation. (French.)

He.

Official Bulletin of the F.A.I.

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE, PARIS

1. General Meeting

The F. A. I. will hold its General Meeting in Geneva on September 17th, 18th and 19th, 1947.

National Aero Clubs will be informed in good time on the details of the programme. The following sessions may be listed :

Commission Meetings

Monday,	Sept. 15th.	Morning :	International Private Flying Commission
		Afternoon :	ditto
Tuesday,	Sept. 16th.	Morning :	International Private Flying Commission
			Gliding Commission
			Model Aircraft Commission
		Afternoon :	International Private Flying Commission
			Gliding Commission
			Model Aircraft Commission
Wednesday,	Sept. 17th.	Morning :	International Air Touring Commission
			Ballooning Commission
			Session of the F. A. I. Directing Committee.

General Meeting of the F. A. I.

Wednesday,	Sept. 17th.	Afternoon :	Opening of the Conference
Thursday,	Sept. 18th.	Morning :	Session
		Afternoon :	Session
Friday,	Sept. 19th.	Morning :	Session
		Afternoon :	Closing session of the Conference
Saturday,	Sept. 20th. :		Boat trip on the Lake of Geneva.

National aero clubs are requested to inform their own delegates before the official invitations to commission members have been issued by the various presidents. In this way, delegates will have sufficient time to prepare for their journeys.

Delegates to the Conference

In view of the restricted hotel accommodation in Geneva, the Swiss Aero Club must be informed well beforehand of how many delegates are attending (besides the members of the Commissions and of the Directing Committee, not more than four per national aero club) and any particular wishes they have as regards accommodation. We therefore ask that the questionnaire be filled out and returned to us as soon as possible.

Report on National Aero Club Activities for 1946

Each Secretary-General is requested to submit the report on his club's activities during 1946 as soon as possible to the General Secretariat of the F. A. I.

2. International Calendar of Events for 1947

The lists published in Nos. 2 (February, 1947) and 5 (May, 1947) of "INTERAVIA REVIEW" may be supplemented as follows :

August 9th : International Air Meeting to mark the official inauguration of Southend-on-Sea municipal airport, England.

3. Route Record Homologated by the F. A. I.

London to Cape Town — 2nd Category (Great Britain)

Squadron Leader H. R. Martin, D. S. O., D. F. C., Pilot. Squadron Leader E. R. Sismore, D. F. C., Navigator.

De Havilland "Mosquito" RG 238, Type P.R. 34, Two Rolls-Royce "Merlin 114A" engines, 1,380/1,200 H.P. each.

April 30th - May 1st, 1947. Distance : 9,673.370 km.

Duration : 21 h. 31 min. 30 sec. Speed : *449.400 km/h.*

THE MONTH IN REVIEW

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POLITICAL

● Following her expulsion from ICAO, *Spain* is to bring into force her *bilateral civil aviation agreements* with *Argentina, Great Britain, Holland, Portugal, Switzerland and the U. S. A.*

● On June 5th the American Government informed the Hungarian Government that aircraft of *Maszovlet*, the Russo-Hungarian airline, would *no longer be allowed to fly over the U. S. Zones of Occupation in Austria and Germany*. The American note simultaneously drew attention to the repeated refusal of the Russian member of the Allied Control Commission to give Pan American World Airways landing rights in Hungary.

● *KLM Royal Dutch Airlines* made a special flight to Moscow on June 19th, carrying a *Dutch air mission invited by the U.S.S.R.*

● CIVIL AVIATION AGREEMENTS have been concluded between the following countries : *Holland and India*, on May 31st in New Delhi ; *Hungary and Czechoslovakia*, on June 7th in Prague ; *Hungary* has been invited by *Yugoslavia* to take part in civil aviation negotiations in Belgrade. Following these negotiations a Hungarian delegation is expected to go to Warsaw for similar negotiations with *Poland*. A *Bulgarian* delegation is expected in Budapest at the end of June for civil aviation discussions. *India and Afghanistan* are also negotiating for a civil aviation agreement ; this will provide for services linking Kabul and Peshawar, Camdahar and Quetta.

NEW AIRCRAFT

● The *XF2D-1 "Banshee,"* a twin-engined carrier jet fighter developed by McDonnell Aircraft Corp., of St. Louis, Mo., for the U. S. Navy, is shortly to be test flown. With two Westinghouse 24-C "Yankee" jet engines housed in the wing roots, the aircraft reportedly attains a maximum speed of over 600 m.p.h. and a rate of climb of 9,000 ft./min.

McDonnell "Banshee" jet fighter.

● The *Fokker F-25 "Promotor,"* the four-seater trainer developed by the Dutch *N. V. Verenigde Nederlandsche Vliegtuigenfabrieken Fokker*, is now being produced in a slightly modified version. Improved cooling and streamlining of the fuselage rear give a better performance on the same power. Maximum speed is 140 m.p.h. instead of 135 m.p.h. ; cruising speed, 137 m.p.h. instead of 121 m.p.h.

Fokker F-25 "Promotor" personal aircraft.

● *Douglas Aircraft Co.* recently completed the second prototype of its *XB-43 "Jetmaster,"* a twin-engined jet-propelled bomber. The aircraft is at present at the Muroc experimental base of the USAAF.

Second prototype of the Douglas XB-43 "Jetmaster."

● *Ryan Aeronautical Co.* has released the first data on its *XFR-4 "Fireball,"* a development of the FR-1 "Fireball." It is powered with a Wright R-1820 "Cyclone" nine-cylinder radial of 1,350 H.P. housed in the nose, and a "Westinghouse 24-C Yankee" turbo-jet engine in the rear of the fuselage. The chief difference from the original model is that the XFR-4 has its air ducts located on the sides of the fuselage instead of in the wing roots.

Ryan XFR-4 "Fireball" carrier-borne fighter.

● At the beginning of last June the *Douglas D-558 "Skystreak"* experimental high-speed aircraft made the first of a series of test flights from the Muroc experimental base. Gene May, Douglas' test pilot, was at the controls.

● *SNCA du Centre*, the French national aircraft concern, has developed a twin-engined torpedo and dive bomber, the *NC 1070*, for the French Naval Air Arm. It is of somewhat unusual configuration in that the engine nacelles extend back as far as the rear tip of the fuselage, and each carries a fin and rudder unit ; the two units support a high-set tailplane. A defence station is located at the rear of the fuselage. The NC 1070 is powered with two SNECMA (Gnome & Rhône) 14R air-cooled 14-cylinder twin-row radials rated at 1,600 C.V. for take-off. A prototype was recently finished and may already be undergoing flight tests.

● *Consolidated Vultee Aircraft Corp.* is developing a reconnaissance flying-boat, the *Consolidated-Vultee XP5J*, for the U. S. Navy. It is powered with four Allison propeller-turbines of 5,500 H.P.

NC 1070 torpedo and dive bomber

INDUSTRIAL

● *S. A. des Ateliers d'Aviation Louis Bréguet*, the French firm, has concluded a license agreement with *Rotol Ltd.* of Gloucester, England, enabling Bréguet to build Rotol airscrews in France.

● *Rolls-Royce, Ltd.*, is considering granting licenses to manufacture or import its aero engines, including the "Nene" and "Derwent" jet-units, to *China and the U.S.S.R.*

● *Aeronautica Industrial S. A. (AISA)*, the Spanish aircraft manufacturers, are building a series of *100 HM-1* two-seater trainers and 60 to 70 *HM-9* target-towing aircraft. A party of officials of the concern is negotiating in London for license rights from *Miles Aircraft Ltd.* for the latter's "Aerovan," "Gemini" and "Messenger" aircraft.

RESEARCH

Boeing "Flying Fortress" with model.

● The *U. S. Navy* air experimental station at Philadelphia is carrying out *trials with model aircraft to provide information on aerodynamic characteristics at speeds close to sonic*. A four-tenth scale model of a Grumman F8F "Bearcat" single-engined carrier-borne fighter is carried under a Boeing "Flying Fortress" and released at a prescribed altitude ; lead ballast helps the model to reach speeds of over 600 m.p.h. during its dive to earth.

INDUSTRIAL PERSONALITIES

● *Herbert John Thomas*, Assistant-Managing Director of The Bristol Aeroplane Co., Ltd., died on May 20th, aged 55. He was also a member of the Council of the Society of British Aircraft Constructors.

● *Leon Charles Desoutter*, pioneer aviation engineer and Managing Director of Desoutter Brothers, Ltd., of Hendon, London, manufacturers of power tools, died on May 20th.

● *Steven J. Zand*, the well-known specialist in aircraft sound-proofing, has been appointed *Vice-President (Engineering) of the Lord Manufacturing Co.*, Erie, Penn, to whom he has been Consulting Vibration Engineer since 1933.

* Excerpts from Nos. 1313/14-1324 (May 28th to June 21st, 1947) of "INTERAVIA, International Correspondence on Aviation," an illustrated newsletter published thrice weekly in four language editions, English, French, Spanish and German.

● *Dr. H. Roxbee Cox,* Director of the National Gas Turbine Establishment, has been appointed *President of the Royal Aeronautical Society* for the 1947-48 year ; he succeeds Sir Frederick Handley Page.

● *Charles C. Walter,* Director and Chief Engineer of The de Havilland Aircraft Co., Ltd., was appointed a *Commander of the Order of the British Empire* in the Birthday Honours conferred by His Majesty King George VI on June 12th.

AIR TRANSPORTATION

● G. S. Lindgren, British Parliamentary Secretary to the Ministry of Civil Aviation, gave the following enumeration in Parliament on May 19th concerning the *number and types of aircraft in use* in the three Government airline corporations : *British Overseas Airways Corp.* has at present 120 aircraft and has or will receive the following by 1951 at the latest : 12 Handley Page "Halton" four-engined converted bombers, 25 Handley Page "Hermes," 16 Avro "Tudor I's," 3 or 4 Bristol 167 "Brabazon I" giant airliners, 12 Short "Sunderland" (Plymouth class) four-engined flying-boats, 12 Short "Solent" class four-engined flying-boats and 3 Saunders-Roe S. R. 45 six-engined flying-boats ; *British European Airways Corp.* has 82 aircraft up to now and has or will receive the following : 50 Vickers "Vikings," 2 Cunliffe-Owen "Concordias," 25 Miles "Marathons" with D. H. "Gipsy Queen" engines and 25 with Armstrong Siddeley "Mamba" propeller-turbines, 3 Sikorsky S-51 helicopters and 2 Bell helicopters ; *British South American Airways Corp.* will add 4 Avro "Tudor IV" and 6 "Tudor V's" to its present 15 aircraft. The distribution of the 14 Bristol 170 "Wayfarer" or "Freighter" twin-engined transports has not been decided, nor has that of the undesignated number of de Havilland D. H. 106 twin-engined all-wing high-speed jet-propelled aircraft ordered for delivery in 1950.

● The *fiscal results of some of the major airline companies in the U. S. A.* for the first quarter of 1947 show that most companies (except Eastern Air Lines, who made a profit of $ 360,000) worked at a loss during that period. Most of these losses are due to the decrease in traffic after the series of aircraft accidents throughout the world at the end of 1946 and beginning of 1947. Directly after the two Douglas DC-4 crashes in the USA at the end of May, load factors were down 30 %. In April, however, business showed a marked improvement.

On June 23rd, President Truman appointed a Board of five experts, headed by James M. Landis, Chairman of the Civil Aeronautics Board, to enquire into the safety of air travel about which he was "deeply concerned, especially in view of recent accidents."

● At the beginning of 1947 there were 81,002 *civil aircraft registered in the United States,* compared with less than 30,000 before the war.

● In order to assist the American aircraft industry over its present difficult period, and to aid foreign airline companies to obtain new aircraft on a credit basis, a system known as a "*participation loan*" has been evolved. This system was recently used to enable KLM Royal Dutch Airlines to acquire 9 Lockheed "Constellations." The Export-Import Bank bears about half the financial burden, whilst the remainder is shared by Lockheed and a New York commercial bank ; the risk to Lockheed is only about 20 % of the purchase price.

● After a two-year study, the U. S. Air Coordinating Committee has recommended that the *U. S. Government should not subsidize the development of airships for commercial purposes.*

● On June 1st, *Trans Canada Air Lines* intensified its *Montreal-Prestwick-London* trans-Atlantic service from five to seven round flights weekly.

● On May 31st *KLM Royal Dutch Airlines* intensified its *Amsterdam—Lisbon—Dakar Natal—Rio de Janeiro—Montevideo* service to two round flights weekly.

● *Flota Aerea Mercante Argentina (FAMA),* the Argentine State-controlled airline, will open a *Buenos Aires—Natal—Canary Islands—Madrid* service on July 9th.

● EUROPE : The *Italian Budget* for the fiscal year ending June 30th, 1947, has been modified to include 89,662,000 *lire for civil aviation purposes.*

● *Alitalia,* the Anglo-Italian airline, will open a *Rome-Tripoli* service in June : this will be the first Italian overseas air service since the war.

● On May 23rd, *TARS,* the Russo-Roumanian airline, and *Maszovlet,* the Russo-Hungarian airline, were able to open their *Budapest—Arad—Bucharest* service. For the time being the service is operated once or twice weekly with LI-2's (Douglas DC-3's built under licence in Russia) ; however, it is planned to intensify the service to three round flights weekly.

● *Ceskoslovenske Aerolinie (CSA),* the Czech airline, opened a *Budapest—Bratislava—Prague* service in pool with *Maszovlet* on June 16th. The route was flown twice weekly until July 15th, when it was intensified to four round flights weekly.

● *Polskie Linie Lotnicze (LOT),* the Polish airline, has a fleet of 36 PS-84's (Douglas C-47 "Dakota" built under licence in the USSR) ; foreign services are operated from Warsaw to Paris, Prague and Berlin, besides a domestic network of 1,350 miles embracing Lotz, Danzig, Breslau, Katowice, Posnan, Stettin, and Cracow.

● On June 2nd *Pan American World Airways* intensified its *California—Hawaii* services from 14 to 20 round flights weekly. Together with *United Airlines'* weekly service, there are now 866 seats available each week for westbound passengers, equalling or possibly exceeding steamship accommodation available between California and Hawaii.

AIRPORTS

● When KLM Royal Dutch Airlines transfers its London terminal from Croydon Airport to *Northolt* in July, all international scheduled services will be operated out of Northolt or London Airport (Heath Row) ; Croydon will only be used for charter services and some of British European Airways Corp.'s domestic routes. — An allocation of Danish Kr. 19,700,000 has been granted for the development of *Kastrup Airport,* Copenhagen. — *Okeckie Airport,* Warsaw, which suffered extensive damage during the war, is being rebuilt ; the terminal building is completed and two concrete runways, 5,904 ft. and 5,380 ft., are already in operation. — The *Turkish Government* has made a contract with two American firms for the construction of *new airfields* and the *development of existing fields* in Turkey at the cost of some 43,000,000 Turkish pounds (approx. $ 6,000,000) over a period of five years. — On May 29th *Willow Run Airport,* near Detroit, was taken over as the *Detroit City Airport* and for the use of the University of Michigan ; the field was built during the war as the factory airfield for the Willow Run aircraft manufacturing facility and has six runways, each over 6,000 ft. long and 150 ft. wide. — On June 1st the *Republic of Panama* opened the new *international airport at Tocumen* (15 miles from Panama City) ; its facilities include a 7,000 ft. runway.

AIRLINE PERSONALITIES

● *Georges de Ro,* President of the Royal Aero Club of Belgium and Vice-President of the F. A. I., died in Brussels last June.

● *Charles Lechevalier,* the Air France pilot who successfully landed a Lockheed "Constellation" at Casablanca after two of its engines failed some 700 miles from the coast, has been made an *Officer de la Légion d'Honneur ;* his radio operator, *Etienne Nemes,* has been appointed *Chevalier de la Légion d'Honneur.*

SERVICE AVIATION

● According to a statement by Brigadier-General Roger Ramey, Commanding General of the USAAF's Eighth Air Force, *all of the 100 Consolidated-Vultee B-36 six-engined very heavy bombers* at present under construction are *to be assigned to the Eighth Air Force.* On June 5th, the U. S. House of Representatives approved the sum of $ 5,280,982,423 *for the War Department's military budget* for the 1948 fiscal year beginning July 1st. The total includes somewhat less than $ 120,000,000 in appropriations and slightly less than $ 280,000,000 in contract authorisations for the procurement of new aircraft and spare parts.

● The Air Council of the *Royal Canadian Air Force* has been reorganised to provide *four separate divisions headed by four Air Members :* Operations and Training (Air Vice-Marshal C. R. Slemon) ; Personnel (Air Vice-Marshal H. L. Campbell) ; Plans (Air Vice-Marshal W. A. Curtis) ; and Technical Services (Air Vice-Marshal A. L. James).

● From September 1st onwards, the strength of the *Belgian Air Force* will be as follows : 652 officers, 1,891 N. C. O.'s and 4,854 men. The number of military aircraft will be increased from its present total of 100 to some 300 ; there will be four fighter squadrons, one night-fighter squadron, one transport squadron and one artillery-observation squadron.

● On July 18th the Swiss National Council approved by 101 votes to 19 the purchase of *75 D.H. 100 "Vampire"* single-seater jet fighters for the *Swiss Air Corps.*

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